Analysis of the Utilities' June 16, 2017, Natural Gas Leak and Emission Reports

SB 1371 (Leno) Natural Gas: Leakage Abatement

R.15-01-008/D.17-06-015

Ed Charkowicz, CPA, CPUC
Fred Hanes, P.E., CPUC
Andrew Mrowka, P.E., ARB
Mihail Cucu, P.E., ARB

January 5, 2018

Table of Contents

Table of Tables

Table of Figures

Executive Summary

This is the third annual report (2016 Joint Report) produced in compliance with SB 1371 (Leno – 2014) on natural gas emissions, as being implemented in Rulemaking (R.) 15-01-008 by the California Public Utilities Commission (CPUC).

Staff from the California Air Resources Board (CARB) and the CPUC jointly prepared this annual report, which analyzes and accounts for natural gas emissions from leaks and vented emissions in the natural gas system in California.[1] This report provides the total estimated emissions of methane – a potent greenhouse gas – from California's utility transmission, distribution and storage systems and discusses emissions by system categories, source categories and leak grades.[2]

On March 31st of each year CPUC Staff issues a data request to gas utilities and independent storage providers (ISPs) in California (Respondents) including reporting templates and associated guidelines. Respondents filed their 2016 data and information with the CPUC on June 16, 2017.

In some cases, additional data requests were necessary to resolve inconsistencies, clarify information to ensure consistency and integrity of the 2016 Joint Report. The report filings and any other relevant data obtained were used to prepare the 2016 Joint Report.[3] Staff made minor adjustments to categorization of 2015 and 2016 data to match up year-over-year (YOY) information that resulted from changes made to 2016 reporting templates.

The 2016 Joint Report looks different than prior Joint Reports in that it:

- Incorporates year-over-year (YOY) comparisons to the 2015 baseline emissions,
- Shows aggregated emissions data and emissions information for selected entities,
- Shows emissions grouped by source type and estimation method, and
- Shows new information based on the changes to this year's reporting templates.

This information should be used by gas system operators to help determine where emission reductions can be achieved to meet the State's goal of reducing methane emissions by 40% by2030,[4] while maintaining the safe and reliable operation of the regulated gas storage and delivery systems.

[1] Unless specified as a fugitive leak or vented emission, for the purposes of this report "emissions" include both fugitive leaks, and vented emissions of natural gas.

[2] "System Category" refers to the grouping of assets by function within the natural gas delivery system. "Source Category" refers to grouping emissions based on like source, e.g. pipelines emissions, or M&R station emissions. See page 9 of this report for definition of leak grades.

[3] R. 15-01-008, *Order Instituting Rulemaking to Adopt Rules and Procedures Governing Commission-Regulated Natural Gas Pipelines and Facilities to Reduce Natural Gas Leakage Consistent with Senate Bill 1371*

[4] This goal was established by (SB 1383, Lara 2016).

As Respondents gain greater insight and understanding of their emissions profiles and sources, they are providing more detailed and accurate data submissions. Some of these insights impacted categorization and accounting of 2016 emissions, and helped identify the potential need to change accounting of 2015 baseline emissions. In cases where the 2016 accounting varied from 2015 accounting Staff explained the changes in reporting the YOY impact.

Staff will track the impact of accounting changes until the Commission decides whether to authorize retroactive changes to the 2015 baseline balances. The potential changes identified in 2016 are relatively small compared to the total and would have a negligible impact on most reduction efforts.

A larger change being considered is updating the 1996 USEPA/Gas Research Institute (GRI) emission factors (EFs) used for the 2015 & 2016 Joint Reports. The USEPA/GRI EFs are over 20 years old and are not California specific. Recent studies suggest that emissions could be significantly lower for distribution mains and services and metering and regulating stations.

CARB is currently evaluating Distribution Mains and Services EFs with the Gas Technology Institute (GTI) and utilities. Discrepancies between pipeline types (e.g. plastic, protected steel) initially reported and the pipeline type reported upon repair means additional analysis is necessary to determine appropriate emission factors. The utilities are working with CARB, but the collection and evaluation of data is ongoing, and more time is required to fully evaluate the survey results and determine the correct EFs.

Key Findings:

Based on respondents 2016 reported data, the total emissions estimate for this sector is 6,267 million standard cubic feet (MMscf) for the 2016 reporting year.[5] This total is 5% lower than the emissions volume reported in 2015.[6] This equates to 2.81 million metric tonnes of carbon dioxide (MMTCO2e) using the Intergovernmental Panel on Climate Change (IPCC) 100- year methane Global Warming Potential (GWP) value of 25 (Fourth Assessment Report (AR4)). Using the 20-year methane GWP value of 72, the 2016 emission estimate equates to 8.08 MMTCO2e.

[5] Note: This intentionally excludes the methane released from the 2015 Aliso Canyon storage failure because the extraordinary failure of the Aliso Canyon storage facility investigation and resultant regulations were handled outside this proceeding. The emissions from Aliso Canyon have been reviewed by CARB and the results are discussed in the Findings and Discussion section of this report.

[6] This reduction coincided with a similar reduction to natural gas system delivered to in-state customers during the year, (see Table 5). However, because of the multiple changes to emissions from various components of the system (see Table 2), it cannot be said with any certainty that this was a "cause and effect" correlation.

Table 1: SB 1371 Sector Emissions - 2015 & 2016

SB 1371 Sector Emissions - 2015 & 2016	2015	2016	YOY Change	YOY % Change
Million Standard Cubic Feet (MMscf)	6,601	6,267	(334)	(5.1%)
100-Year Global Warming Potential (GWP) MMTCO2e	2.96	2.81	(0.15)	(5.1%)
20-Year Global Warming Potential (GWP) MMTCO2e	8.51	8.08	(0.43)	(5.1%)

This report also analyses emissions by two categories: Emissions by Systems (Table 2) and Emissions by Source Classification (Table 3).

Table 2: Systems Categories (Emissions for 2015 & 2016)

System Categories	2015 (MMscf)	2015 % of Total	2016 (MMscf)	2016 % of Total	YOY Difference (MMscf)	YOY % Change Inc/(Decr)
Transmission Pipeline	549	8%	433	7%	(116)	(21.1%)
Transmission M&R Station	1,007	15%	983	16%	(24)	(2.4%)
Compressor Station	163	2%	145	2%	(18)	(10.8%)
Distribution Mains & Services	1,703	26%	1,602	26%	(101)	(5.9%)
Distribution M&R Stations	1,348	20%	1,319	21%	(29)	(2.1%)
Customer Meter	1,638	25%	1,645	26%	7	0.4%
Underground Storage	193	3%	139	2%	(54)	(28.1%)
Total	**6,601**	100%	**6,267**	100%	**(335)**	**(5.1%)**

As shown in Table 3, the Distribution Mains and Services graded leak emissions make up 22% of total 2016 reported emissions, consistent with 2015 emissions. The majority of the remaining 78% of emissions come from population based leaks (62%),[7] blowdown/vented emissions (8%),[8] pipeline damages (6%), and other leaks (2%).[9]

[7] Population based emissions are merely the population units multiplied by the appropriate EF, and not based on actual measurements of leaks and emissions. These emissions can only change if the population or EF changes.
[8] Vented emissions include operational blowdowns, automatic pressure relief valves, and other venting done for safety or operational reasons.
[9] Other Leaks include fugitive leaks from compressors, compressor components, storage systems, and storage components.

Table 3: Emissions Grouped by Source Classification (2015 Compared to 2016)

Emissions Grouped by Source Classification (2015 Compared to 2016)	2015 (MMscf)	% of Total	2016 (MMscf)	% of Total	YOY Change (MMscf)	YOY % Change
Population Based Emissions	3,931	**60%**	3,898	**62%**	(32)	(1%)
Graded Pipeline Leaks	1,458	**22%**	1,401	**22%**	(58)	(4%)
Blowdown and Vented Emissions	861	**13%**	507.466	**8%**	(354)	(41%)
Damages	318	**5%**	365	**6%**	47	15%
Other Leaks	33	**1%**	95	**2%**	62	185%
Total Sector Emissions	**6,601**	**100%**	**6,267**	**100%**	**(335)**	**(5.1%)**

The population based emissions fall into the following categories (Figure 3):

- Metering and Regulation (M&R) stations (both transmission and distribution) 36% of the total 2016 emissions,
- Customer Meters 26%, and
- Transmission Pipeline 0.1%,

The M&R Stations and Customer Meters emissions are based on the installed population of units (i.e. the customer meter set assembly (MSA) is a population unit) multiplied by an EF. As expected, the population based leak estimates did not change appreciably, with only a 1% decrease in total reported emissions. Actual emissions from these systems will not change unless the number of units in the population decreases, or the EF values change.

Virtually all of the YOY decrease occurred in the Blowdown and Vented emissions category with a decrease of 354 MMscf, from 2015 reported levels, which corresponds to 41% decrease from 2015 to 2016 for that category alone (Table 3). PG&E and SoCalGas had the largest decreases of 214 MMscf (47%) and 129 MMscf (35%) respectively.

PG&E attributes the decrease to bundling its maintenance projects so that one blowdown serves several projects, and from a focused effort to decrease pressures prior to blowdown.[10] SoCalGas indicates that its efforts to re-route gas and decrease line pressures before blowdowns played a big role in this decrease. SoCalGas reported a 42 MMscf reduction due to pressure reductions before blowdowns while San Diego Gas & Electric (SDG&E) reported 0.12 MMscf reduction for the same practice.

[10] Based on the information provided the amount of the decrease that resulted from each of the activities cited as causal factors in the emissions reduction could not be determined.

Table 4: Calculated Emissions Volume by Leak Grade (2016)[11]

Calculated Emissions Volume by Leak Grade	Carried Over to 2016 (Mscf)	Discovered in 2016 (Mscf)	Estimated Unsurveyed (Mscf)	Total (Mscf)	% of Total	% of Total Emissions: (6,266,544 Mscf)
Grade 1	450	47,990	-	**48,440**	3.5%	0.8%
Grade 2	14,015	59,734	-	**73,749**	5.3%	1.2%
Grade 3	437,154	291,586	-	**728,741**	52.0%	11.6%
Unsurveyed - No grade	-	-	549,682	**549,682**	39.2%	8.8%
AG - Haz	-	-	-	**-**	0.0%	0.0%
AG - Non-Haz	-	0.12	-	**0.12**	0.0%	0.0%
Total (Mscf)	**451,619**	**399,311**	**549,682**	**1,400,613**	100.0%	22%

Graded leak emissions from distribution mains and services (DM&S), as detailed in Table 4, remained roughly the same, with a 4% YOY decrease.[12] However, the 2016 Grade 1 leak volumes comprise 3.5% of the total, Grade 2 about 5.3%, Grade 3 at 52%, and leaks estimated to come from un-surveyed areas (not given a grade) at 39%.[13]

The 2016 Joint Report estimates leaks occurring on the un-surveyed portions of Respondents' service territory based on the known 2016 leak rate for the surveyed territory. These estimated un-surveyed leaks amount to 549,682 Mscf or 39.2% of the graded leaks category, and comprise 8.8% of the total 2016 sector emissions.

The emissions from pipeline damages make up 6% of total emissions and increased by 47 MMscf or 15% from 2015 levels (Table 3); these are considered one of the least controllable categories of emissions due to the random nature of damages to pipelines. The trend should be monitored because, while damages are expected to vary from year to year, a general downward trend would indicate the efficacy of any mitigation. [14]

Lastly, emissions from Other Leaks increased by 62 MMscf, almost entirely due to including two new reporting categories in 2016 for Transmission and Storage components. These leaks comprise about 2% of the 2016 total emissions (Table 3).

[11] The table includes Above Ground (AG) leaks because they make up part of the leaks and to ensure there is no question about transparency of the data they were broken out as a separate line item.
[12] Transmission pipeline leak volumes are included but only make up 0.4% of graded leaks and 0.08% of total emissions.
[13] Grade 1 leaks are leaks that represent an existing or probable hazard to persons or property and require prompt action. Grade 2 leaks are leaks that are not hazardous at the time of detection but justify a scheduled repair based on potential for a future hazard. Grade 3 leaks are leaks that are not hazardous at the time of detection and can reasonably be expected to remain non-hazardous.
[14] In 2016 the transmission pipeline damages increased by 83 MMscf from 2015, offset by a decrease of distribution pipeline damages of 36 MMscf resulting in a net increase of combined pipeline damages of 47 MMscf or 15.1%.

Conclusion:

The major findings from the 2016 data are:

1. The total 2016 reduction of 5% from 2015 baseline emissions were primarily driven by reduction in blowdown and venting emissions. There were small decreases in pipeline leaks and compressor emissions, but those were offset by small increases in emissions from damages and component leaks and emissions (Table 1).
2. Significant reductions in blowdown emissions took place in 2016 attributed to implementation of Best Practices (BPs) for bundling work, concerted efforts to reduce line pressure before blowdown, and cyclical changes in facilities maintenance. The amounts of emission reduction associated with these different activities are difficult to evaluate due to the Respondents' failure to apply performance metrics and collect the necessary empirical data.
3. The majority of reported emissions (62%) come from population based emission estimates that rely on Emission Factors (EFs) rather than actual measurements, and are expected to remain relatively constant over time (Table 3). Significant changes to EFs may occur based on improved information and could ultimately affect baseline emissions levels.
4. The second largest emissions category (22%) is DM&S graded leaks (Table 3). Grade 3 leaks make up 52% of graded leak volume, and 12% of the total overall emissions volume (Table 4). Grade 3 leaks make up 96.5% of the leaks that go unrepaired for extended periods, and virtually all the leaks carried over from prior years. For example, eliminating the backlog of grade 3 leaks carried over to 2016 could decrease the overall 2016 emissions inventory by 7%.[15]
5. Anticipated DM&S emissions from un-surveyed service territories make up 39.2% of the 2016 graded leaks (Table 4). The estimated un-surveyed emissions make up about 9% of the total 2016 sector emissions. Increasing the frequency of leak surveys, as ordered by the CPUC in D.17-06-015, should reduce graded pipeline emissions, because leaks will be detected and repaired more quickly.

###

[15] The 7% emissions reduction is based on the 2016 grade 3 leaks carried over from prior years of 437 MMscf which is 7% of the 2016 emissions. Grade 3 leaks are discovered every year and all else being equal, eliminating the carryover of grade 3 leaks from prior years would net 7% of 2016 reported emissions.

Introduction and Background

In accordance with Senate Bill (SB) 1371 (Leno, Chapter 525, Statutes of 2014; Pub. Util. Code §§ 975, 977, 978), the California Air Resources Board (ARB) and California Public Utilities Commission (CPUC) prepared this annual report, which analyzes and accounts for methane from leaks and vented emissions from natural gas transmission, distribution and storage in California.[16] On September 14, 2014, Governor Jerry Brown signed into law SB 1371 that requires reporting and verification of emissions of greenhouse gases (GHG) and also requires gas corporations to file a report summarizing utility leak management practices, a list of new methane leaks by grade, a list of open leaks that are being monitored or are scheduled to be repaired, and a best estimate of gas loss due to leaks.

In January 2015, the Commission opened an Order Instituting Rulemaking (R.) 15-01-008 (OIR) to implement the provisions of SB 1371. SB 1371 requires the adoption of rules and procedures to minimize natural gas leakage from Commission regulated natural gas pipeline facilities consistent with Pub. Util. Code § 961(d), § 192.703(c) of Subpart M of Title 49 of the Code of Federal Regulation, the Commission's General Order (GO) 112-F, and the state's goal of reducing greenhouse gas (GHG) emissions.

On June 15, 2017, the Commission in D.17-06-015 (Gas Leak Decision) approved the Natural Gas Leak Abatement Program consistent with SB 1371. This decision established Best Practices (BPs) and reporting requirements for the CPUC Natural Gas Leak Abatement Program developed in consultation with CARB.[17] The decision implements the following to support the goal to reduce methane emissions by 40% by 2030:

1. Annual reporting for tracking methane emissions;
2. Twenty-six mandatory BPs for minimizing methane emissions pertaining to policies and procedures, recordkeeping, training, experienced trained personnel, leak detection, leak repair, and leak prevention;
3. Biennial compliance plan incorporated into the respondents' annual Gas Safety Plans, beginning in March 2018; and

[16] Unless specified as a fugitive leak or vented emission, for the purposes of this report "emissions" include both fugitive leaks, and vented emissions of natural gas.
[17] Leno, Chapter 525, Statutes of 2014; Pub. Util. Code §§ 975, 977, 978

4. Cost recovery process to facilitate Commission review and approval of incremental expenditures to implement Best Practices (BPs), Pilot Programs and Research & Development.

In the Gas Leak Decision, the Commission affirms that the 2015 baseline emissions estimates will provide the starting point to measure future natural gas emissions reductions.[18] The rulemaking (R.15-01-008) remains open to address implementation issues in a second phase.

In addition, SB 32, which sets a 40% greenhouse gas reduction target for 2030, was passed and signed into law in 2016.[19] This additional legislation directs CARB to develop plans to reduce statewide methane emissions, which it did in the Short-Lived Climate Pollutants strategy (SB 605 (Lara, Chapter 523, Statutes of 2014).

Methane is a very potent GHG, which has an impact many times greater than carbon dioxide. According to the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4), methane is 72 times more potent than CO2 over a 20-year time frame. Although the more recent IPCC Fifth Assessment Report (AR5) estimates a global warming potential (GWP) value 86 times higher than CO2 over a 20-year span, the AR4 values are used for consistency with prior Reports.

Purpose of the Gas Leak Abatement Report:

The report estimates emissions from the gas storage and delivery systems in aggregate and by entity, by system categories, source classification and by grade. The information should be used by the gas system operators to help determine where emission reductions can be achieved while maintaining the safe and reliable operation of commission-regulated gas pipelines and other facilities. The metrics used to compile this report provide operators, the Commission, and the public with reasonably accurate information about the type, number, and severity of emissions and the quantity of gas emitted to the atmosphere over time.

This report provides a summary of the 2016 emissions inventory reports submitted by the respondents on June 16, 2017.

This year's Joint Report differs from prior reports in a few ways as follows:

- Incorporates year-over-year (YOY) comparisons to the 2015 baseline emissions,

[18] http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=190740714, Finding of Fact #13, pg. 145.
[19] California Global Warming Solutions Act of 2006: emissions limit. SB32, Pavley, Reg. Sess. 2015-2016. (2016).

- Shows aggregated emissions data and emission information from selected entity,
- Shows emissions grouped by source type and estimation method, and
- Shows new information based on the changes to this year's reporting templates.

The distribution mains and services (DM&S) pipeline leaks are categorized according to their "grade".

- Grade 1 leaks are leaks that represent an existing or probable hazard to persons or property and require prompt action.
- Grade 2 leaks are leaks that are not hazardous at the time of detection but justify a scheduled repair based on potential for a future hazard.
- Grade 3 leaks are leaks that are not hazardous at the time of detection and can reasonably be expected to remain non-hazardous.
- Above ground DM&S leaks are not graded, but are designated in a similar manner to denote what repair priority they should receive.[20] They are classified as Above Ground – Hazardous (AG-Haz), Above Ground - Non-Hazardous (AG-Non-Haz), and Above Ground – Non-Hazardous – Minor.

Even though the system categories of emissions are the same as in 2015, a greater effort was made to standardize the data submissions to improve consistency and integrity of the data. To ensure consistency, the data request continued to require the use of 1996 GRI emissions factors (EFs) for this year's report.[21] The 2016 Joint Report covers emissions and leaks for components within system categories. Additionally, the report includes general discussions of changes to operational practices, new methods for leak and emission detection and mitigation programs. Lastly, improvements to data capture (e.g. performing inventory verification of assets), and methodology for estimating emissions (e.g. calculating emissions for all blowdowns not just those above a specific threshold), may provide greater accuracy in future reporting cycles.

Basis for the Annual Gas Leak Abatement Report:

On April 4, 2017, Staff issued a data request to CPUC jurisdictional utilities and independent storage providers (ISPs) in California to collect the information required by

[20] Above Ground leaks are not statutorily required to be graded and are subject to each utility own nomenclature.
[21] See Appendix 9 of the Data Request for specific EFs recommended by each System Category. http://www.cpuc.ca.gov/General.aspx?id=8829

Article 3, Section 975 (c) and (e)(6), using templates jointly developed by CPUC and CARB. (See Appendix C for detailed wording.)

The data was separated into the following seven systems categories (which included subgroupings by type):

1. Transmission Pipelines (leaks, damages, blowdowns, components, and odorizers);
2. Transmission Metering and Regulation (M&R) stations (station leaks and emissions, and blowdowns);
3. Compressor stations (compressor leaks and emissions, blowdowns, components leak and emissions, and storage tanks);
4. Distribution Pipeline Mains and Services (leaks, damages, and blowdowns);
5. Distribution M&R stations (station leaks and emissions, and blowdowns);
6. Customer Meters (leaks, and venting); and
7. Underground Storage Facilities (leaks, compressors leaks and emissions, blowdowns, and component leaks and emissions. Dehydrators are omitted in 2016).

The respondents provided contextual information and explanations for their data to help understand the composition of the emissions, emission sources and related calculations underlying the emission estimates. The respondents summarized the data and provided their system-wide leak information. Appendix A explains methods used to estimate emissions.

CARB and CPUC Staff jointly analyzed the data and requested supplementary information for clarification. The "Lessons Learned" section of this report identifies insights Staff acquired about potential improvements to the process and opportunities to enhance future data requests.

Findings and Discussion

Leaks and Emissions:

Based on the utilities and ISPs reports, CARB and CPUC Staff estimate that the natural gas sector statewide emissions were approximately 6,267 MMscf in 2016, which equates to 2.81 MMTCO2e (AR4, 100-year methane life cycle) (see Table 1). This is a 5% YOY decrease from 2015 reported emissions of 6,601 MMscf or 2.96 MMTCO2e.[22]

[22] Total Natural Gas emissions reported to the CPUC/CARB for the 2016 annual report without Aliso Canyon come to 6,267 MMscf which translates to 118,026 metric tonnes of methane. See Appendix D for calculations.

System Wide Leak Rate

The System-wide Leak Rate is an important metric that could show the correlation with reductions in emissions or reductions in throughput. SB 1371 requires the establishment and annual monitoring of a System-wide Leak Rate for the transmission and distribution system.[23]

The 2015 Joint Report calculated a System-wide Leak Rate of 0.32% (emissions of about 6,601 MMscf divided by throughput of 2,056,950 MMscf). The 2016 system wide leak rate of 0.33% is consistent with that of 2015 (on emissions of about 6,267 MMscf divided by 1,877,179 MMscf of throughput) (Table 5.) There is a small YOY increase of 4% because the overall emissions decreased 5.1% the throughput decreased 8.7%, which had an increasing effect on the overall emissions rate. The emissions from storage facilities and compressor stations may be directly impacted by changes in throughput, but not the population based emissions.

The throughput decreases in 2016 is attributed to a warmer than average 2015-2016 winter resulting in less withdrawal by customers, and consequently less volume injected into storage.

Table 5: System Wide Emissions – Throughput Categories (2015 & 2016)

System-Wide Emissions - Throughput Categories	2015 Inventory (MMscf)	2016 Inventory (MMscf)	YOY % Change
Total Emissions	**6,601.2**	**6,266.5**	**(5.1%)**
Total Storage Annual Volume of Injections to Storage	199,522	116,579	(41.6%)
Total Transmission Annual Volume of Gas Used by the Gas Department	7,717	6,107	(20.9%)
Total Transmission Volume of Annual Gas transported to or for Customers in state	1,832,676	1,736,336	(5.3%)
Total Transmission Volume of Annual Gas transported to or for Customers out of state	16,775	18,002	7.3%
Total Distribution Annual Volume of Gas Used by the Gas Department	261	156	(40.2%)
Total Throughput	**2,056,950**	**1,877,179**	**(8.7%)**
System-Wide Emissions Rate	**0.32%**	**0.33%**	**4.0%**

[23] Refer to Appendix C for PUC Code Section 975(e)(6), Article 3

2016 Categorization Adjustments

This report reflects a few minor categorization adjustments to the data reported for 2016. All of these adjustments are discussed in more detail later in the Report:[24]

1. The 2016 reporting templates sought additional component emissions and leak data for M&R
2. The 2016 reporting templates sought to change the way damages were categorized by requiring respondents to separate their MSA damages from their DM&S damages.
3. In the 2015 Joint Report, Storage component leaks and emissions were reported separately in the 2016 reporting templates; (in 2015 they were combined as one item)
4. Respondents provided new information on dehydrator assets and practices, and the report includes actual emissions based on Respondents' specific dehydrator emissions.

Aliso Canyon Storage Facility:

Beginning in October 2015 and lasting through February 2016, operators of the Aliso Canyon gas storage facility in Southern California reported an uncontrolled leak preliminarily attributed to the failure of well pipe casing below ground level. Based on the CARB analysis, the Aliso Canyon leak event contributed about 5% to California's statewide natural gas emissions in 2015.[25] The CARB has estimated a total quantity of 99,650 metric tonnes of methane emissions for the duration of the leak.[26]

This event raised the national awareness of the risks associated with natural gas storage facilities. Consequently, this large leak resulted in new storage facility regulations. The environmental risks from this single leak were substantial and the safety, operations and maintenance regulations are still under examination.

The catastrophic nature of the Aliso Canyon emissions is included for context, but they are largely outside the scope of this Report.

[24] These changes had negligible impact on reported emissions.
[25] The 78,895 MT of CH4 equated to 1.97 MM MT CO2e or 4.7% of estimated 2015 CH4 emissions assuming 2014 and 2015 CH4 overall emissions would be the same. Calculated emissions based on CARB report page 25 data.
https://www.arb.ca.gov/research/aliso_canyon/aliso_canyon_methane_emissions-arb_final.pdf
[26] Ibid, Pg.1.

Key Findings:

In 2016, the general trend was a decrease in YOY emissions, with a few exceptions. The top four emitters made up 99.7% of the reported emissions. As noted in Table 6, most Respondents reported incremental improvements.

The largest reduction in reported emissions of 244,559 Mscf (7.4% YOY reduction) came from PG&E's systems, followed by 82,833 Mscf from SoCalGas (3.0% YOY reduction). The largest percent reductions (within 0.1% of each other) occurred at Wild Goose Storage with 10,702 Mscf (44.6 %) and Central Valley Gas Storage with 361 Mscf (44.7%) YOY changes (See more details in section for Underground Storage).

Alpine Gas, the Respondent with the lowest reported emissions in 2015 and 2016, reported the largest percentage change between 2015 and 2016, which may be due to the change in the reporting of MSA leaks. The overall impact was small due to the size of Alpine Gas.

Table 6: Emissions by Utility and Independent Storage Provider (2015 & 2016)

Utility and Independent Storage Provider (ISP)	2015 Volume (Mscf)	%	2016 Volume (Mscf)	%	YOY Change	YOY % Change
Pacific Gas & Electric	**3,294,368**	49.91%	**3,049,809**	48.67%	**(244,559)**	(7.4%)
Southern California Gas	**2,779,853**	42.11%	**2,697,020**	43.04%	**(82,833)**	(3.0%)
San Diego Gas & Electric	**282,041**	4.27%	**282,759**	4.51%	**718**	0.3%
Southwest Gas	**214,309**	3.25%	**217,324**	3.47%	**3,015**	1.4%
Wild Goose GS	**24,003**	0.36%	**13,301**	0.21%	**(10,702)**	(44.6%)
Gill Ranch GS	**3,636**	0.06%	**3,772**	0.06%	**135**	3.7%
Lodi GS	**1,638**	0.02%	**1,476**	0.02%	**(162)**	(9.9%)
Central Valley GS	**806**	0.01%	**445**	0.01%	**(361)**	(44.7%)
West Coast GS	**509**	0.01%	**391**	0.01%	**(117)**	(23.1%)
Alpine Natural Gas	**6**	0.00%	**245**	0.00%	**240**	4282.1%
Total	**6,601,169**	**100%**	**6,266,544**	**100%**	**(334,626)**	**(5.1%)**

Figure 1: 2016 Emissions by Reporting Entity

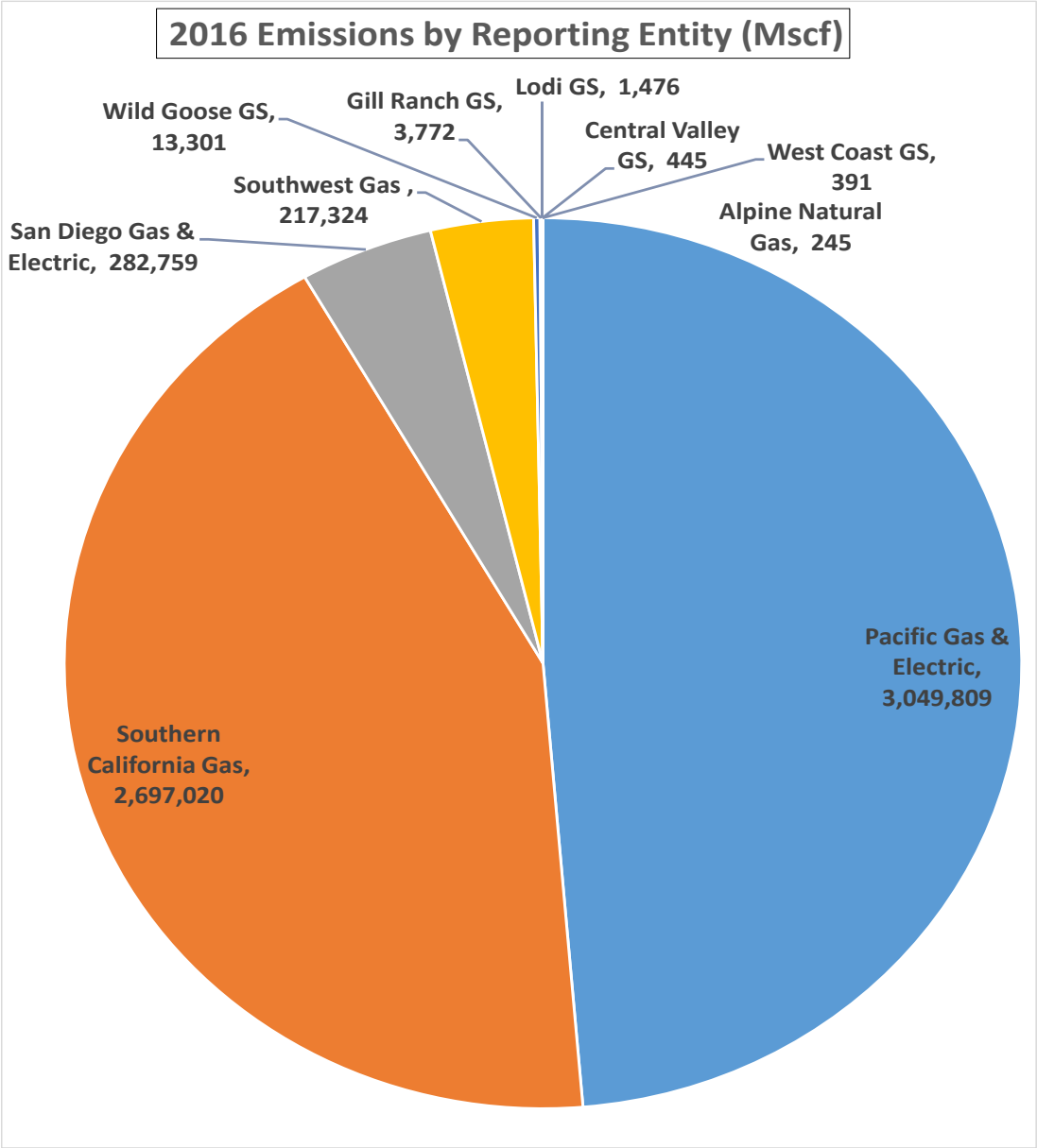
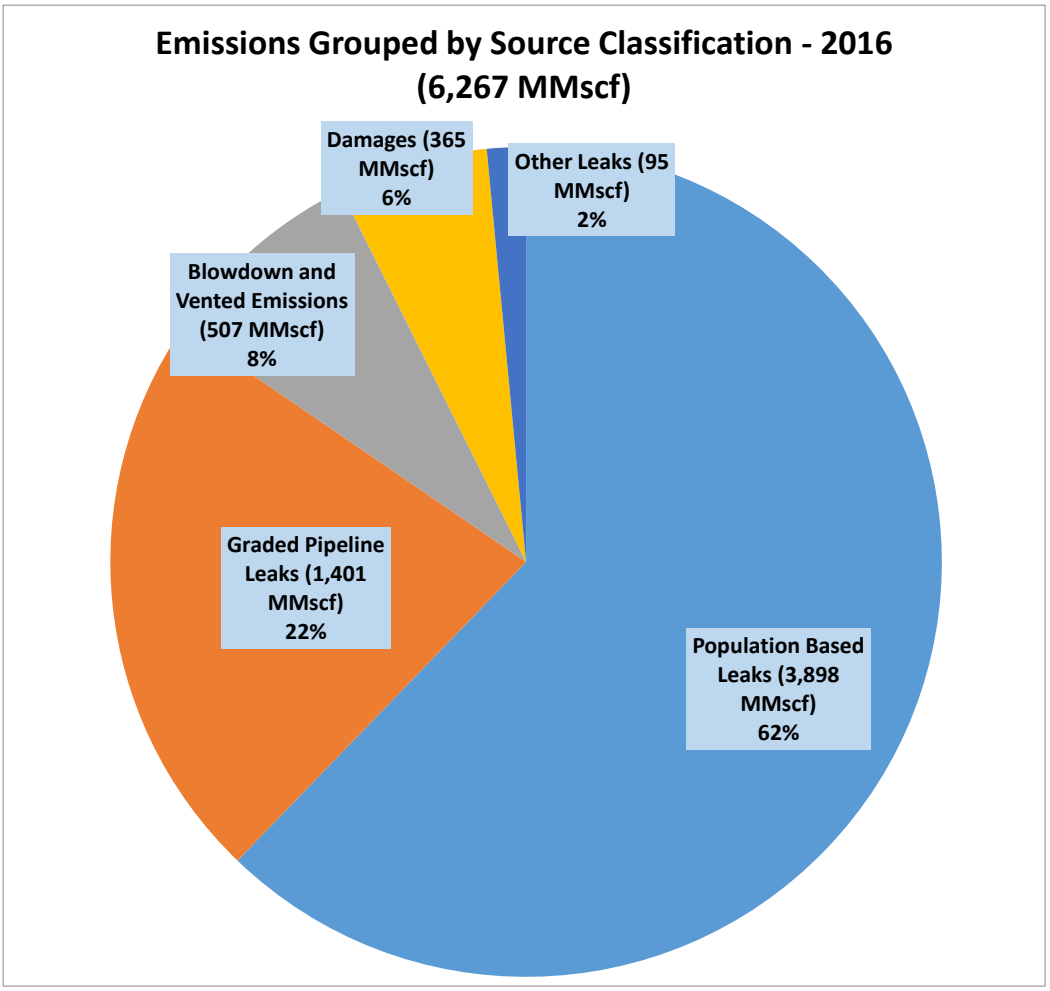


Table 7 shows the emissions by systems category and the sub-categories included in the system category. The 2016 emissions are compared to 2015 baseline emissions with the YOY changes.

Table 7: System Categories (Emission Details - 2015 & 2016)

System Categories	2016 Total (Mscf)	%	Emission Source	Classification	2015 Volume (Mscf)	%	2016 Volume (Mscf)	%	YOY Change	YOY % Change
Transmission Pipelines	**433,427**	6.9%	Pipeline Leaks	Population Based	**5,238**	0.08%	**5,118**	0.08%	**(120)**	(2.3%)
			All Damages	Damages	**81,793**	1.24%	**164,729**	2.63%	**82,936**	101.4%
			Blowdowns	Blowdown/ Vented	**455,055**	6.89%	**246,946**	3.94%	**(208,110)**	(45.7%)
			Component Emissions	Blowdown/ Vented	**4,592**	0.07%	**14,237**	0.23%	**9,645**	210.0%
			Odorizers	Blowdown/ Vented	**2,570**	0.04%	**2,398**	0.04%	**(172)**	(6.7%)
Transmission M&R Stations	**983,055**	15.7%	Station Leaks & Emissions	Blowdown/ Vented	**941,622**	14.26%	**931,280**	14.86%	**(10,342)**	(1.1%)
			Blowdowns	Blowdown/ Vented	**65,583**	0.99%	**51,775**	0.83%	**(13,807)**	(21.1%)
			Component Emissions	Blowdown/ Vented	**21**	0.00%	**-**	0.00%	**(21)**	(100.0%)
Transmission Compressor Stations	**145,160**	2.3%	Compressor Emissions	Blowdown/ Vented	**106,257**	1.61%	**52,101**	0.83%	**(54,157)**	(51.0%)
			Blowdowns	Blowdown/ Vented	**31,088**	0.47%	**44,510**	0.71%	**13,423**	43.2%
			Component Emissions	Blowdown/ Vented	**7,186**	0.11%	**11,695**	0.19%	**4,509**	62.7%
			Component Leaks	Other Leaks	**18,153**	0.27%	**26,575**	0.42%	**8,422**	46.4%
			Storage Tank Leaks & Emissions	Other Leaks	**3**	0.00%	**10,279**	0.16%	**10,276**	311387.9%
Distribution Main & Service Pipelines	**1,602,027**	25.6%	Pipeline Leaks	Pipeline Leaks	**1,458,399**	22.09%	**1,400,613**	22.35%	**(57,786)**	(4.0%)
			All Damages	Damages	**236,145**	3.58%	**200,604**	3.20%	**(35,541)**	(15.1%)
			Blowdowns	Blowdown/ Vented	**5,046**	0.08%	**810**	0.01%	**(4,236)**	(83.9%)
			Component Emissions	Blowdown/ Vented	**3,281**	0.05%	**-**	0.00%	**(3,281)**	(100.0%)
Distribution M&R Stations	**1,319,336**	21.1%	Station Leaks & Emissions	Population Based	**1,347,773**	20.42%	**1,319,005**	21.05%	**(28,768)**	(2.1%)
			Blowdowns	Blowdown/ Vented	**295**	0.00%	**331**	0.01%	**36**	12.3%
Customer Meters	**1,644,997**	26.3%	Meter Leaks	Population Based	**1,635,911**	24.78%	**1,643,029**	26.22%	**7,119**	0.4%
			Vented Emissions	Blowdown/ Vented	**2,363**	0.04%	**1,968**	0.03%	**(395)**	(16.7%)
Underground Storage	**138,542**	2.2%	Storage Leaks & Emissions	Other Leaks	**15,016**	0.23%	**15,630**	0.25%	**613**	4.1%
			Compressor Emissions	Blowdown/ Vented	**96,313**	1.46%	**25,163**	0.40%	**(71,151)**	(73.9%)
			Compressor Leaks	Other Leaks	**-**	0.00%	**2,083**	0.03%	**2,083**	N/A
			Blowdowns	Blowdown/ Vented	**46,358**	0.70%	**28,927**	0.46%	**(17,432)**	(37.6%)
			Component Emissions	Blowdown/ Vented	**14,947**	0.23%	**26,595**	0.42%	**11,649**	77.9%
			Component Leaks	Other Leaks	**-**	0.00%	**40,133**	0.64%	**40,133**	N/A
			Dehydrator Vent Emissions	Blowdown/ Vented	**20,163**	0.31%	**11**	0.00%	**(20,152)**	(99.9%)
TOTAL	**6,266,544**	**100%**			**6,601,169**	**100%**	**6,266,544**	**100%**	**(334,626)**	**(5.1%)**

Figure 2: Emissions Grouped by Source Classification - 2016



Population based leaks make up 62% of the total 2016 emission as shown in Figure 2.[27] Similar to 2015, the graded leak emissions in 2016 Joint Report make up 22% of all reported emissions. Though blowdown and vented emissions make up only 8% of total 2016 emissions this category accounted for the greatest amount of YOY reductions.[28] Pipeline damages made up 6% of 2016 emissions and had a slight uptick from 2015 levels.[29] Other Leaks make up the remaining 2%. Most of the 62 MMscf increase in Other Leaks from 2015 to 2016 is due to the addition of new items captured in the reporting templates (Table 3).

[27] The number in the population, of a given asset or component, multiplied by the appropriate EF to estimate the emissions for that system asset such as MSAs and M&R Stations.

[28] Vented emissions include operational blowdowns, automatic pressure relief valves, assets that vent as a function of their design, and other venting done for safety or operational reasons.

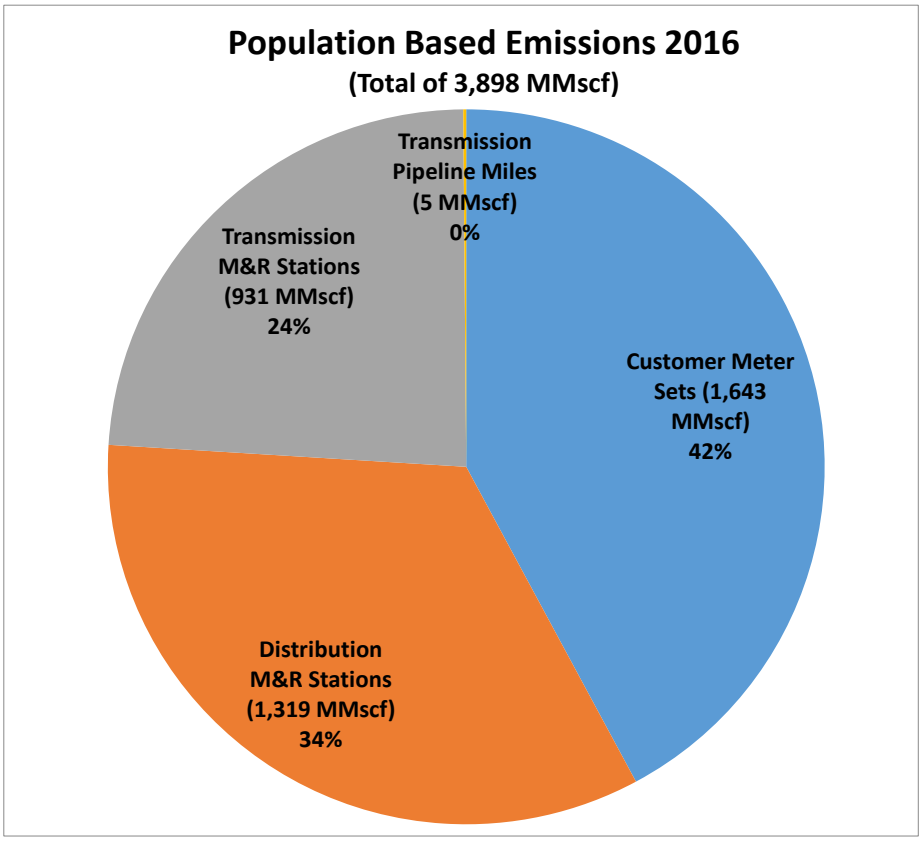
[29] In 2016 the transmission pipeline damages increased by 83 MMscf from 2015, offset by a decrease of distribution pipeline damages of 36 MMscf resulting in a net increase of combined pipeline damages of 47 MMscf or 15.1%.

Population Based Emissions:

The population based emissions are broken down in the following categories and shown in Figure 3:

- Metering and Regulation (M&R) stations (both transmission (24%) and distribution (34%)) make up 58% of population emissions and comprise 36% of the 2016 total emissions,
- Customer Meters leaks comprise 42% of population based emissions and 26% of 2016 total emissions, and
- Ungraded Transmission Pipeline leaks just are less than 0.1% of the population and total emissions.

Figure 3: Population Based Emissions 2016



The M&R Station and Customer Meter emissions are based on the population of units multiplied by an EF. Transmission pipeline leaks are based on an EF per mile of installed transmission pipeline.

As expected the population based leak estimates did not change appreciably with a 1% decrease in total reported emissions. Unless items are re-categorized, or the number of units or the EF changes, the amount of emissions will remain constant YOY. The small difference between 2015 and 2016 is due to updated records of the number of M&R Stations and an increase in the number of customer meters.

Blowdown and Vented Emissions:

The largest YOY decrease in emissions occurred in the Vented/Blowdown emissions, with a decrease of 353,652 Mscf (41%) from 2015 reported levels. PG&E and SoCalGas had the largest decreases of 214,435 Mscf (47%) and 128,758 Mscf (35%) respectively. PG&E reports that bundling maintenance projects coupled with decreasing line pressures prior to blowdown had the largest impact. SoCalGas also attributes its decrease to isolating and decreasing line pressures as well as the cyclical nature of maintenance activities.

Table 8: Blowdown and Vented Emissions (2015 & 2016)

Blowdown and Vented Emissions	2015 (Mscf)	2016 (Mscf)	YOY Change (Mscf)	YOY % Change
Transmission Assets - Blowdown:				
Pipeline	455,055	246,946	(208,110)	(45.7%)
M&R Stations	65,582	51,775	(13,807)	(21.1%)
Compressor Blowdowns	31,088	44,510	13,423	43.2%
Total Transmission Assets - Blowdown:	**551,726**	**343,232**	**(208,494)**	**(38%)**
Transmission Assets - Venting:				
Pipeline Components - Venting	7,162	16,635	9,473	132.3%
Compressor Emissions	106,257	52,101	(54,156)	(51.0%)
Compressor Component Emissions	7,207	11,695	4,488	62.3%
Total Transmission Assets - Venting:	**120,626**	**80,430**	**(40,196)**	**(33%)**
Distribution Asset - Blowdowns:				
Pipeline	5,046	810	(4,236)	(83.9%)
M&R Stations	295	331	36	12.3%
Total Distribution Asset - Blowdowns:	**5,340**	**1,141**	**(4,199)**	**(79%)**
Distribution Asset - Venting:				
Component Emissions	3,281	0	(3,281)	(100.0%)
Customer Meter Venting	2,363	1,968	(395)	(16.7%)
Total Distribution Asset - Venting:	**5,645**	**1,968**	**(3,676)**	**(65%)**
Storage Asset Venting:				
Compressors	96,313	25,163	(71,151)	(73.9%)
Storage Components/Dehydrators	81,467	55,532	(25,935)	(31.8%)
Total Storage Asset Venting:	**177,781**	**80,695**	**(97,086)**	**(55%)**
Total Blowdown and Venting Emissions	**861,117**	**507,466**	**(353,652)**	**(41%)**

Graded Pipeline Leaks Distribution Mains and Services (DM&S) Graded Leaks:

DM&S graded leaks decreased slightly by 57,787 Mscf to 1,400,612 Mscf in 2016, or 4% YOY.[30] As shown in Table 4, the 2016 grade 1 leak volumes comprise 3.5% of the total sector emissions; grade 2 is 5.3%, and grade 3 make up the remaining 52%.[31] See detailed discussion of DM&S systems leaks and emissions below.

The 2016 Joint Report includes utilities' estimated proportion of leaks occurring between surveys in all of their service territory based on the actual 2016 leak rate for the portion of territory surveyed. Also shown in Table 4, 39.2% (549,682 Mscf) of the pipeline leaks are estimated to come from the un-surveyed areas (referred to as "un-surveyed leaks"), and comprise about 8.8% of the total 2016 emissions.

Damages:

The emissions from damages increased 47 MMscf or 15% from 318 MMscf in 2015.This is one of the least controllable categories of emissions due to the random nature of damage to pipeline assets (Table 3). Damages are expected to vary from year to year, but over time the trend should generally be downward if mitigation efforts are effective.

Other Leaks:

Lastly, emissions from Other Leaks increased in large part due to inclusion of two new reporting categories in 2016 for Transmission and Storage components. These leaks made up virtually all of the 62 MMscf change and comprise about 2% of the total emissions reported in 2016 (Table 3). The increased emissions had a negligible impact on total emissions.

[30] In 2015 the transmission pipeline leak volumes are included but only make up 0.4% of graded leaks and 0.08% of total emissions.
[31] Grade 1 leaks are leaks that represent an existing or probable hazard to persons or property and require prompt action. Grade 2 leaks are leaks that are not hazardous at the time of detection but justify a scheduled repair based on potential for a future hazard. Grade 3 leaks are leaks that are not hazardous at the time of detection and can reasonably be expected to remain non-hazardous.

Detailed Discussion for Each of the Seven Systems Categories

Transmission Pipeline:

Four utilities reported transmission pipeline emissions of 433,427 Mscf, which is a decrease of 21.1% from last year's report of 549,248 Mscf.

Table 9: Transmission Pipeline (Emissions - 2015 & 2016)

Emission Source Categories	2015 (Mscf)	2015 % of Total	2016 (Mscf)	2016 % of Total	YOY Change (Mscf)	YOY % Change Inc/(Decr)
Pipeline Leaks	5,238	1.0%	5,118	1.2%	(120)	(2.3%)
All Damages	81,793	14.9%	164,729	38.0%	82,936	101.4%
Blowdowns	455,055	82.9%	246,946	57.0%	(208,110)	(45.7%)
Component Emissions	4,592	0.8%	14,237	3.3%	9,645	210.0%
Oderizers	2,570	0.5%	2,398	0.6%	(172)	(6.7%)
Transmission Pipeline Total	549,248	100%	433,427	100%	(115,821)	(21.1%)

Findings (Table 9):

- The emissions in the transmission pipeline leaks category did not change significantly from 5,238 Mscf in 2015 to 5,118 Mscf in 2016, which is based on the miles of transmission pipeline multiplied by an EF.
- Damages from third parties showed an increase in emissions from 81,793 Mscf in 2015 to 164,729 Mscf in 2016 due to an increased number of events and longer durations to repair transmission pipelines.
- Blowdown emissions decreased 208,110 Mscf from 455,055 Mscf in 2015 to 246,949 Mscf in 2016. Respondents reported that project bundling resulting in fewer events, the natural ebb and flow of maintenance procedures, lowering line pressures prior to blowdown, and more accurate measurements are factors contributing to the decrease. For all respondents, the number of blowdown events decreased by 887 (68%) from 1,311 to 424. More work needs to be done to show how each of the various changes to operating practices actually impact emissions.
    - A third of the emission reduction resulted from a change in the calculation method used by PG&E. In 2016 PG&E changed its methodology and calculated the discrete amount gas released from all smaller blowdown events. In 2015, for smaller blowdown events PG&E used the median figure of 125 Mscf (between 0 and 250 Mscf) for those transmission pipeline clearances that were estimated to produce an emission less than 250 Mscf. In 2016 PG&E no longer

estimated its clearances below 250 Mscf, but instead used an engineering calculation to more accurately estimate all pipeline clearances. Using this method, the mean average of the clearance volumes below 250 Mscf is 47 Mscf, which is considerably less than the 125 Mscf value assumed in 2015. If the mean average was retrospectively applied to the 2015 data, the 2015 blowdown volume would be 67,444, Mscf lower. See Appendix F for calculation details.

- Component emissions increased from 4,592 Mscf to 14,237 Mscf, largely due to re-categorization of assets that were included in other categories or omitted from 2015.

Transmission M&R Stations:

Four utilities reported total transmission M&R station emissions of 983,055 Mscf for 2016, which was a 2.4% decrease from 1,007,226 Mscf for 2015.

Table 10: Transmission M&R Station (Emissions - 2015 & 2016)

Emission Source Categories	2015 (Mscf)	2015 % of Total	2016 (Mscf)	2016 % of Total	YOY Change (Mscf)	YOY % Change Inc/(Decr)
Station Leaks & Emissions	941,622	93.5%	931,280	94.7%	(10,342)	(1.1%)
Blowdowns	65,582	6.5%	51,775	5.3%	(13,807)	(21.1%)
Component Emissions	21	0.0%	-	0.0%	(21)	(100.0%)
Transmission M&R Station Total	1,007,226	100%	983,055	100%	(24,170)	(2.4%)

There is a decrease of 13,807 Mscf (21.1%) for M&R station blowdowns in 2016. PG&E made up virtually all the emissions in this category and attributed its decrease of 13,974 Mscf to bundling maintenance activities and reducing line pressure prior to the blowdown. SoCalGas had a very small increase of 171 Mscf in emissions attributed to normal yearly variation in maintenance cycles.

In 2015, entities reported Component Leaks and Component Emissions together on one worksheet, and in 2016, at Staff's request, Component Leaks and Component Emissions were reported on separate worksheets. The Component Emissions are the vented emissions that occur by design or operation of the components, while the Component Leaks are the unplanned, fugitive leaks.

Transmission Compressors:

Three respondents reported total transmission compressor station emissions of 145,160 Mscf, which was a 10.8% decrease from 162,686 Mscf in 2015. The percentage of these

emissions compared to the total from all categories remains roughly the same with 2.5% in 2015 and 2.3% in 2016.

Table 11: Transmission Compressor Station (Emissions - 2015 & 2016)

Emission Source Categories	2015 (Mscf)	2015 % of Total	2016 (Mscf)	2016 % of Total	YOY Change (Mscf)	YOY % Change Inc/(Decr)
Compressor Emissions	106,257	65.3%	52,101	35.9%	(54,156)	(51.0%)
Blowdowns	31,088	19.1%	44,510	30.7%	13,423	43.2%
Component Emissions	7,186	4.4%	11,695	8.1%	4,509	62.7%
Component Leaks	18,153	11.2%	26,575	18.3%	8,422	46.4%
Storage Tank Leaks & Emissions	3	0.0%	10,279	7.1%	10,276	314756%
Compressor Station Total	162,686	100%	145,160	100%	(17,527)	(10.8%)

The subcategory compressor emissions have decreased 54,156 Mscf or 51% from 106,257 Mscf in 2015 to 52,101 Mscf in 2016.[32] Staff notes that a compressor can have a significantly different scf/hour rating for pressurized operating state, pressurized idle, and depressurized idle YOY. In 2018, reporting methods will be modified to address this by taking measurements more frequently to reflect the contemporaneous changes to compressor emissions that may correlate them to maintenance activities.[33]

Blowdown emissions increased 13,426 Mscf or 43.2% from 31,088 Mscf in 2015 to 44,510 Mscf in 2016 due to several factors contributing to these changes. The largest impact comes from 6,303 Mscf due to the inclusion by PG&E of compressors whose activity and emissions were omitted in prior reporting years because they fell below CARB's Mandatory Reporting Requirement (MRR). This requirement will be clarified during the annual reporting workshop planned for winter 2018.[34] The rest of the increase is due to normal fluctuations in maintenance activity.

In the 2015 Joint Report there was only one category for capturing both component leaks and emissions. In 2016, Respondents reported Component Leaks and Component Emissions separately. To enable comparison, Staff separated the 2015 reported emissions in accordance with these definitions. The Component Emissions increase 4,509 Mscf from 2015

[32] GO 112-F, and PHMSA regulations required compressor operators to take one measurement of each of their compressors in its various states (e.g. pressurized operation, pressurized idle, non-pressurized idle) as an EF. The measured EF is multiplied by the number of hours in each state to estimate the emissions per compressor. There is no provision when to take the measurement, such as after maintenance, at the beginning of the year. However, new CARB regulations require operators to take quarterly measurements starting in 2018 (CCR, Title 17, Division 3, Chapter 1, Subchapter 10 Climate Change Article 4. Subarticle 13).

[33] Ibid.

[34] The Joint Staff report intends to capture all system emissions that can be reasonably identified, estimated and/or measured; SB 1371 does not restrict the reporting of emissions to the MRR guidelines.

to 11,695 Mscf in 2016, and Component Leaks increased 8,422 Mscf from 2015 to 26,575 Mscf in 2016.

Operators do not currently track all the repairs performed on component leaks at compressor facilities. Due to their size and familiarity with their operations, the smaller ISPs could identify the specific repairs made for the leaks found at their facilities. However, both PG&E and SoCalGas could not document the repair dates of leaks detected in prior years, or whether leaks detected during 2016 facility surveys were repaired. PG&E and SoCalGas historically have not tracked the repair of minor leaks by tightening, lubrication, *and* adjustment but claim that when a leak is found, this occurs immediately. SoCalGas committed to implementing new procedures to record all component leak repair activities. For 2018 reporting, Staff will address the need for better record-keeping for compressor station leak repair to ensure compliance with BPs.

Storage Tanks:

Storage Tank Leaks and Emission increased from 3 Mscf to 10,279 Mscf in 2016, due to 2 LNG storage tank leaks detected by PG&E at one of its facilities in 2016.

Distribution Mains and Services (DM&S):

Six respondents reported total DM&S emissions of 1,602,027 Mscf, which is 100,844 Mscf or a 5.9% decrease from last year's total of 1,702,871 Mscf. This comprised the second largest system category for 25.6% of total gas emissions.

The emissions from DM&S pipeline leaks showed a slight decrease of 57,786 MMscf from 1,458,399 Mscf in 2015 to 1,400,613 Mscf in 2016, which by itself makes up 22% of total emissions (Table 7).

Table 12: Distribution Mains and Services (DM&S) (Emissions - 2015 & 2016)

Emission Source Categories	2015 (Mscf)	2015 % of Total	2016 (Mscf)	2016 % of Total	YOY Change (Mscf)	YOY % Change Inc/(Decr)
Pipeline Leaks	1,458,399	85.6%	1,400,613	87.4%	(57,786)	(4.0%)
All Damages	236,145	13.9%	200,604	12.5%	(35,541)	(15.1%)
Blowdowns	5,046	0.3%	810	0.1%	(4,236)	(83.9%)
Component Emissions	3,281	0.2%	-	0.0%	(3,281)	(100.0%)
Distribution Mains & Services Total	1,702,871	100%	1,602,027	100%	(100,844)	(5.9%)

Staff continues to work with Respondents to improve the methodology for calculating emissions from un-surveyed portions of their territory. In 2016, the template was updated to

include new worksheets to calculate and summarize emissions consistently. Consequently, Staff worked with respondents to ensure that they filled out the worksheets correctly.

The DM&S damages showed a decrease from 236,145 Mscf in 2015 to 200,604 Mscf. This category includes about 15 MMscf of MSA above ground damages (See #2 on page 18).

There were fewer blowdowns in 2016, which consequently reduced the volume of emissions from 5,045 Mscf in 2015 to 810 Mscf. Also, due to re-categorization of the component emissions, there were no emissions to report for 2016; however, the report retained the line item since emissions were reported in 2015.

Detailed Discussion of DM&S Leaks and Emissions:

Utilities reported more incidents of DM&S pipeline leaks than all of the other sources in the survey combined. Six respondents reported a total of 57,015 leaks. Respondents provided data for: leak discovery date, repair date, leak grade, pipeline classification as either main or service, pipeline material, method of discovery, and calculated emissions. Respondents provided other parameters for informational purposes that were not used in calculations, such as: address of leak, pipe size, pressure, and scheduled date of repair.

Table 13: Calculated Emissions Volume by Leak Grade (2016)

Calculated Emissions Volume by Leak Grade	Carried Over to 2016 (Mscf)	Discovered in 2016 (Mscf)	Estimated Un-surveyed (Mscf)	Total (Mscf)	% of Total	% of Total Emissions: (6,266,544 Mscf)
Grade 1	450	47,990	-	**48,440**	3.5%	0.8%
Grade 2	14,015	59,734	-	**73,749**	5.3%	1.2%
Grade 3	437,154	291,586	-	**728,741**	52.0%	11.6%
Un-surveyed - No grade	-	-	549,682	**549,682**	39.2%	8.8%
AG - Haz	-	-	-	**-**	0.0%	0.0%
AG - Non-Haz	-	0.12	-	**0.12**	0.0%	0.0%
Total (Mscf)	**451,619**	**399,311**	**549,682**	**1,400,613**	100.0%	22%

In 2015, 33,987 leaks were estimated in un-surveyed territory, which contributed emissions of 660,493 Mscf. In 2016, there were fewer leaks, 21,743 estimated in un-surveyed territory, which contributed 549,682 Mscf of emissions (Table 13). The number of anticipated leaks in the un-surveyed area dropped by about 12,240 (36%), however the emissions associated with un-surveyed areas only dropped 110,811 Mscf (17%). This is due to the fact

that, although there were fewer leaks, the leaks that occurred had higher emissions, either from longer duration or because they involved pipe material with higher EFs.[35]

Table 14: Emissions from Open Leaks (Comparison of 2015 & 2016)

Emissions from Open Leaks	2015 (Mscf)	2016 (Mscf)	YOY Change	YOY % Change
Grade 1	91,580	48,440	(43,140)	(47%)
Grade 2	84,977	73,749	(11,228)	(13%)
Grade 3	621,349	728,741	107,392	17.%
Un-surveyed - No grade	660,493	549,682	(110,811)	(17%)
AG - Non-Haz	-	0.12	0.12	-
Total	**1,458,399**	**1,400,613**	**(57,787)**	(4%)

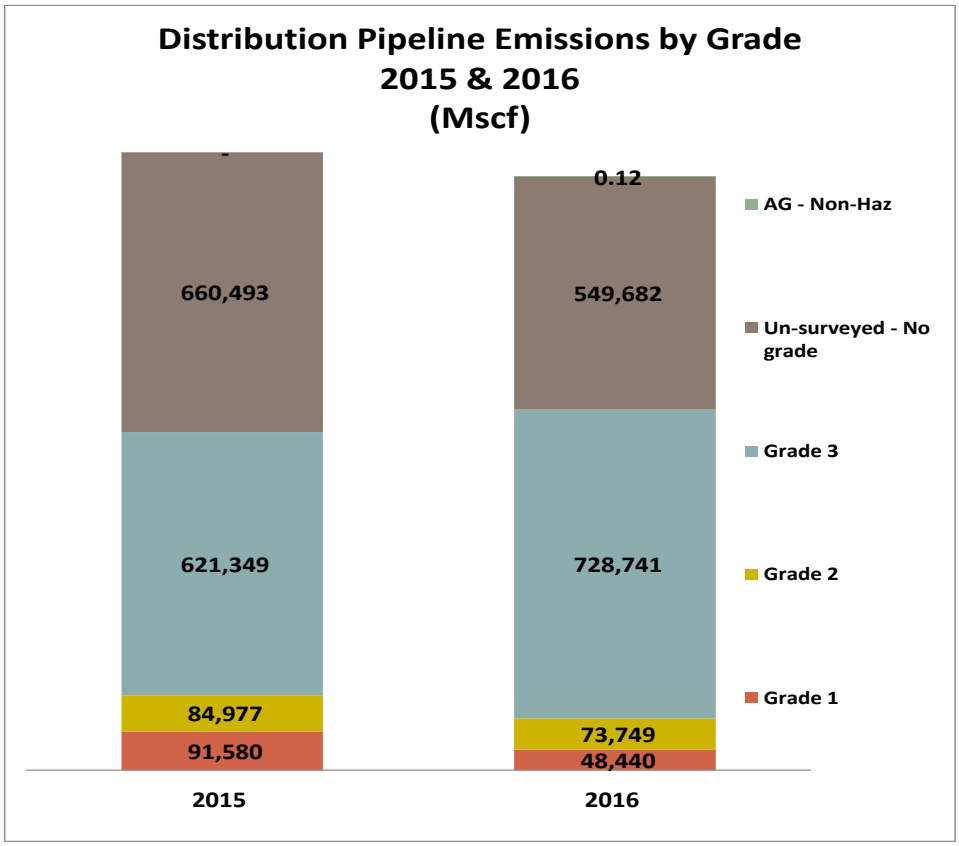
Of the actual leaks discovered in 2016, grade 1 leaks were 26% less than 2015 and grade 2 were 19% less. Only the number of grade 3 leaks discovered increased by 11%. The overall number of leaks discovered fell by 10%. The leak discovery rate helps determines the number of leaks estimated in the un-surveyed territories, which also drives the associated emissions.

Table 15: Leaks Discovered (2015 Compared to 2016)

Leaks Discovered	2015	2016	YOY Change	YOY % Change
Grade 1	8,957	6,669	(2,288)	(26%)
Grade 2	4,648	3,778	(870)	(19%)
Grade 3	8,071	8,966	895	11.%
Total	**21,676**	**19,413**	**(2,263)**	(10%)

[35] EFs vary significantly based on the type of pipe material.

Figure 4: Distribution Pipeline Emissions by Grade 2015 & 2016



Average Days to Repair Leaks[36]

The overall average days-to-repair leaks appear to be within the timeframes allowed by statutory and regulatory requirements.

Table 16: 2016 - Average Days to Repair by Entity (Graded Leaks)

2016 - Average Days to Repair by Entity			
Entity	Grade 1	Grade 2	Grade 3
PG&E	1.3	63.3	1,067.3
SCG	1.8	163.6	838.0
SDG&E	1.3	57.7	131.5
SWG	1.0	17.4	88.9
WCG	-	-	-
Weighted Average	**1.5**	**88.7**	**849.5**

[36] The formula for average days to repair leaks is the average of "Repair date minus discovery date plus one day."

For example, while most Grade 1 leaks were repaired within 1 day, in rare cases repair times were longer. In several instances, leaks that PG&E originally designated grade 3, were upgraded to a grade 1 or 2, but the original discovery date as a grade 3 was reflected in the raw data. The times to repair these upgraded leaks were statistical "outliers" at the tail end of the distribution for repair of grade 1 or 2 leaks. However, PG&E could not provide the date of upgrade for our analysis.

To prevent skewing the data, Staff omitted these outlier leaks from the average time to repair calculation. The calculation of the average time to repair graded leaks used 98.7% of the data and omitted 1.3% of the "outlier" repaired leaks.

Table 17: Leak Count by Grade and by Entity (2016)

Leak Count by Grade and by Entity	Carried Over to 2016	Discovered in 2016	Total	% of Total	Repaired in 2016	Carried Over to 2017	Carried Over % of Total
PG&E	71	3,965	4,036	60%	4,036	0	-
SCG	4	2,274	2,278	34%	2,278	0	-
SDG&E	0	410	410	6%	410	0	-
SWG	0	20	20	0%	20	0	-
WCG	0	0	0	0%	0	0	-
Grade 1 Total	**75**	**6,669**	**6,744**	**19.2%**	**6,744**	**0**	**0.0%**
PG&E	844	2,535	3,379	67%	3,349	30	4%
SCG	434	1,127	1,561	31%	934	627	92%
SDG&E	20	100	120	2%	98	22	3%
SWG	0	16	16	0%	16	0	0%
WCG	0	0	0	0%	0	0	0%
Grade 2 Total	**1,298**	**3,778**	**5,076**	**14.4%**	**4,397**	**679**	**3.2%**
PG&E	5,964	4,466	10,430	45%	215	10,215	50%
SCG	8,277	4,462	12,739	55%	2,569	10,170	50%
SDG&E	1	3	4	0%	4	0	0%
SWG	5	26	31	0%	29	2	0%
WCG	3	9	12	0%	0	12	0%
Grade 3 Total	**14,250**	**8,966**	**23,216**	**66.0%**	**2,817**	**20,399**	**96.4%**
PG&E	37	80	117	98%	35	82	100%
SCG	0	2	2	2%	2	0	0%
SDG&E	0	0	0	0%	0	0	0%
SWG	0	0	0	0%	0	0	0%
WCG	0	0	0	0%	0	0	0%
AG - Non-Haz Total	**37**	**82**	**119**	**0.3%**	**37**	**82**	**0.4%**
Total Known Leaks	**15,660**	**19,495**	**35,155**	**100%**	**13,995**	**21,160**	**100%**
PG&E	0	14,564	14,564	67%	N/A	N/A	-
SCG	0	6,423	6,423	30%	N/A	N/A	-
SDG&E	0	728	728	3%	N/A	N/A	-
SWG	0	28	28	0%	N/A	N/A	-
WCG	0	0	0	0%	N/A	N/A	-
Unsurveyed - No grade Total	**0**	**21,743**	**21,743**	**38.2%**	**0**	**0**	**0.0%**
Grand Total	**15,660**	**41,238**	**56,898**	**100%**	**13,995**	**21,160**	**100%**

Above Ground (AG) Leaks (Not Graded)

In the 2015 Joint Report, there was a concern that not all leaks were graded. The 2016 template worksheets explicitly included categories for three ungraded Above Ground leak designations. Grading above ground leaks is not required by regulation and is not standard industry practice. The above ground leaks that are not graded are classified as "Above Ground Hazardous", "Above Ground Non-Hazardous", and "Above Ground Non-Hazardous Minor." However, PG&E grades their Above Ground Non-Hazardous leaks and includes any emissions associated with Above Ground leaks in their respective graded category. The Staff adjusted the data to accurately reflect PG&E's Above Ground Non-Hazardous and prevent duplication. As noted, Respondents are generally reporting their un-surveyed leaks without proportionately allocating them by grade. However, Staff would like to understand whether the respondents have empirical data that can be used to allocate the leaks that are estimated for their un-surveyed areas, not only by leak grade but also by pipe material.

Pipe Material Type

One important data element in estimating leak volume is the pipe material since each material type has a specific EF. In PG&E's case, for the majority of leaks the material type is not known and it assumes that the estimated leaks occur in different pipe materials in the same proportions as known leaks occur in different pipe materials. However, this fails to account for the fact that some pipeline materials have been installed disproportionately throughout the service territory, accordingly, this estimation method likely miss-states the emissions from these leaks.

PG&E uses a weighted average of the known leak's EFs to come up with a hybrid EF for its leaks with unknown material type. This is a temporary solution until we devise a better method for allocating the leaks to an appropriate material type.

Staff is concerned that this issue could have other safety ramifications because different pipeline materials have different EFs and require different repair methodologies. Without complete information, PG&E could make suboptimal short and long-term pipeline repair decisions where pipeline materials have a bearing on the decision.

As noted, Respondents are generally reporting their un-surveyed leaks without proportionately allocating them by grade. For future reports, Staff would like to understand whether the respondents have empirical data that can be used to allocate the leaks that are estimated for their un-surveyed areas, not only by leak grade but also by pipe material.

Distribution M&R Stations:

Four respondents reported total distribution M&R station emissions of 1,319,336 Mscf, which is 28,732 Mscf (2.1%) less than the 2015 total of 1,348,067 Mscf. Virtually all of the emissions come from the M&R stations leaks and emissions, with only 331 Mscf from blowdown emissions. Distribution M&R stations have the highest EF in the inventory for above ground M&R stations.[37] Therefore, Distribution M&R Stations remain one of the largest sources of emissions.

Table 18: Distribution M&R Stations (Emissions - 2015 & 2016)

Emission Source Categories	2015 (Mscf)	2015 % of Total	2016 (Mscf)	2016 % of Total	YOY Change (Mscf)	YOY % Change Inc/(Decr)
Station Leaks & Emissions	1,347,773	100.0%	1,319,005	100.0%	(28,768)	(2.1%)
Blowdowns	295	0.0%	331	0.0%	36	12.3%
Distribution M&R Stations	1,348,067	100%	1,319,336	100%	(28,732)	(2.1%)

Customer Meters:

Six respondents reported emissions from customer meters totaling 1,644,997 Mscf, which is 6,723 Mscf (0.4%) greater than the 2015 total of 1,638,274 Mscf. The increase is due to additional customer meters. In 2016, this system category has the largest share of the total emissions at 26.3%, and comprises the largest share of population based emission estimates.

Table 19: Customer Meter (Emissions - 2015 & 2016)

Emission Source Categories	2015 (Mscf)	2015 % of Total	2016 (Mscf)	2016 % of Total	YOY Change (Mscf)	YOY % Change Inc/(Decr)
Meter Leaks	1,635,910	99.9%	1,643,029	99.9%	7,119	0.4%
Vented Emissions	2,363	0.1%	1,968	0.1%	(395)	(16.7%)
Customer Meter Total	1,638,274	100%	1,644,997	100%	6,723	0.4%

In addition, in 2016 four of the six respondents reported vented emissions of 1,968 Mscf, a reduction of 395 Mscf (16.7%) from 2015.

Starting in 2016, Staff added worksheets for; a) damages, b) actual Meter Set Assemblies (MSA) leaks and c) component emissions within the customer meter category. Review and evaluation of this data, though not included in the emissions inventory, may

[37] The EF for Distribution system above grade M&R Stations with an inlet pressure of 300 PSI or greater is 1,648.5 Mscf/year/station. The emissions are driven by the size of the EF and the number of stations.

eventually allow reporting emissions in this systems category based on actual measurements, rather than population/EF based estimated emissions.

Out of the six respondents, only PG&E failed to report their damages in the template for MSA damages. PG&E explained that they were not capable of separating out the MSA related damages from their DM&S damages that they reported in Appendix 4 - DM&S damages data.

In 2015 the above ground MSA and DM&S pipeline damages were reported together as DM&S damages of 200,604 Mscf. Because PG&E could not separate its MSA damages from its DM&S damages Staff aggregated the 2016 MSA damages (15,116 Mscf) reported by other Respondents with the DM&S pipeline damages (185,488 Mscf) for a combined total of 200,604 Mscf, that is reported as DM&S damages in the 2016 Joint Report.

The YOY DM&S damages are comparable, but MSA damages are not reported as a subcategory of Customer Meter emissions in the 2016 Joint Report. Staff will explore ways to separate PG&E's 2016 MSA damages from their DM&S pipeline damages so they may be reported separately in the future.

Underground Storage:

Six respondents reported underground storage systems emissions totaling 138,542 Mscf for 2016, which is a 28.1% decrease from 192,797 Mscf for 2015.

Table 20: Underground Storage (Emissions - 2015 & 2016)

Emission Source Categories	2015 (Mscf)	2015 % of Total	2016 (Mscf)	2016 % of Total	YOY Change (Mscf)	YOY % Change Inc/(Decr)
Storage Leaks & Emissions	15,016	7.8%	15,630	11.3%	613	4.1%
Compressor Emissions	96,313	50.0%	25,163	18.2%	(71,151)	(73.9%)
Compressor Leaks	-	0.0%	2,083	1.5%	2,083	NA
Blowdowns	46,358	24.0%	28,927	20.9%	(17,432)	(37.6%)
Component Emissions	14,947	7.8%	26,595	19.2%	11,649	77.9%
Component Leaks	-	0.0%	40,133	29.0%	40,133	NA
Dehydrator Vent Emissions	20,163	10.5%	11	0.0%	(20,152)	(99.9%)
Underground Storage Total	192,797	100%	138,542	100%	(54,255)	(28.1%)

Significant changes:

- The subcategory Storage Leaks and Emissions changed slightly from 15,016 Mscf in 2015 to 15,630 Mscf, up about 4.1%.
- The storage compressor emissions decreased 71,151 Mscf (73.9%) from 2015 emission of 96,313 Mscf to 25,163 Mscf. (In 2016, the compressor emissions portion was reported

separately from compressor fugitive leaks.) The YOY change in compressor emissions is due to reduced operations at both SoCalGas and PG&E facilities (see more details below under storage blowdowns) as well as a the temporary shutdown of PG&E's McDonald Island facility, and changes in the annual survey to measure each compressor's scf/hour EF for each operating state.[38] Similar to compressors used in transmission, there are new regulations that will require quarterly testing, which may reduce dramatic fluctuations in the EF from measurement to measurement.

- Blowdown emissions decreased as well from 46,358 Mscf in 2015 to 28,927 Mscf in 2016 due to reduced blowdowns, warmer heating season reducing activity levels, seasonal changes and multi-year maintenance cycles. The following lists drivers in blowdown and corollary compressor emissions reduction:[39]
  a. As a result of the 2015 Aliso Canyon leak, authorities directed the Aliso Canyon storage field to reduce operations for inspections and repairs. The reduced pressurized operations reduced the need for blowdowns, and therefore resulted in reduced emissions.
  b. McDonald Island storage field:
     - In 2015, McDonald Island had issues with the emergency shutdown (ESD) equipment that activated the ESD system purging the system in accordance with safety protocols. Even though this problem was intermittent it caused several station blowdowns. The issue was investigated and repaired. As a result, the number of ESD decreased by 11 from 2015 to 2016 significantly reducing emissions from blowdowns.
     - PG&E kept compressor units online during reduced injection rate periods rather than shutdown the unit. A shutdown results in a blowdown.
     - A warmer than average 2015-2016 winter shortened the withdrawal season resulting in fewer hours of pressurized operation. Less compressor run-time equates to less blowdowns.
     - Due to higher inventory carryover of natural gas, fewer injections were needed to reach maximum storage capacity for the following winter. This also contributed to less compressor run-time and blowdowns.

[38] The annual compressor survey establishes the EF for its operating states, e.g. pressurized operation, pressurized idle and non-pressurized idle.
[39] We included PG&E's thorough breakdown of the issues and activities that occurred in 2015/2016 which helped Staff more fully understand the YOY changes in emissions and provided useful examples of practices that may mitigate emissions in storage systems.

- Due to a new Division of Oil, Gas, and Geothermal Resources (DOGGR) regulation requiring additional surveys of storage fields, PG&E identified a reservoir leak. The two-month leak investigation required a shut-in of the storage field during this time when no injection or withdrawal occurred. Accordingly, the related compressor units were offline for two months, which also resulted in fewer withdrawal and injections (compressor runs) for the remainder of 2016.
- PG&E initiated reliability improvements for compressor Units K-1 and K-2 that reduced; a) the number of unit shutdowns in 2016, and b) blowdowns as a result of corrective replacement of the gas cooler rotating equipment during annual maintenance of these two compressors. As a result, each compressor unit's blowdown volume was significantly reduced throughout 2016.
- In 2015, a large number of operating and equipment issues occurred with the rental compressors (K-7, K-8, and K-9). Improvements in preventative maintenance, compressor loading, and tuning were performed throughout 2015 to increase reliability and engine efficiency. These actions resulted in reduced unit shutdowns, lowering the unit's number of blowdown.

In addition, component leaks and vented emissions were shown as one category in 2015 with an emissions total of 14,947 Mscf. In 2016, component emissions and component leaks were reported separately. The 2016 "component emissions" are 26,595 Mscf, and the component leaks are 40,133 Mscf. If the 2016 component leaks and emissions are combined for a total 66,728 Mscf, then this compares to the 14,947 Mscf reported in 2015. The 51,782 Mscf difference is attributed to accounting for emissions not previously reported as well as better knowledge of systems assets. Continued monitoring of these component leaks and emission will help understand long term changes and trends.

Dehydrators:

Six entities reported operating dehydrator facilities in 2015 and 2016. In 2015, three respondents reported emissions totaling 20 MMscf based on the EFs provided in the reporting templates. Three ISPs did not report any emissions because all methane gas vented by the dehydrators was routed to a vapor recovery unit (VRU) and incinerated by a thermal oxidizer.

In 2016, based on concerns that dehydrator emissions were not being reported consistently, Staff investigated the types of dehydrators and emissions used by respondents.

Staff found that virtually all operators use glycol based dehydrators and either use a thermal oxidizer, or pipe the distilled flash gas for use as a fuel in its heat exchangers. In all but one case, the dehydrator's flash gas is combusted so that no natural gas is vented to the atmosphere.

Only PG&E reported dehydrator-vented emissions at on dehydrator facility, where it measured emissions of 11 Mscf in 2016. Even though this is a glycol based dehydrator that recycles its flash gas in a heat exchanger, not all the flash gas is used and the excess is vented.

The 2015 dehydrator emissions were overstated because the reporting template only provides an EF for dehydrators that are desiccant based, or directs respondents to use a CARB MRR calculation for dehydrator vented natural gas.[40] Respondents followed the template guidelines, even if their dehydrators had no vented emissions.

Staff has decided that, in the future, Respondents using glycol dehydrators with vapor recovery unit (VRU) and a thermal oxidizer, or that use all of the flash gas as a fuel should report zero vented natural gas emissions for their dehydrators. Those respondents that use desiccant dehydrators or that have glycol dehydrators without a VRU and destruction device that completely combusts the natural gas should report emissions using the appropriate EF provided or their measured emissions.

Staff will include this update in the winter 2018 workshop.

[40] The EF provided in the data request for desiccant dehydrators is 2.23E-03 MT CH4/MMscf, with the alternative CARB MRR calculation "Eq. 5 in MRR".

Responses to Data Request Questions #1 and #7

Responses to Data Request Question #1:

Question 1 asks each respondent to provide: "A summary of changes to utility leak and emission management practices from January 1st, 2016 to December 31st, 2016. The report must include a detailed summary of changes, including the reasoning behind each change and an explanation of how each change will reduce methane leaks and emissions."

Utilities' responses to Question #1 can be grouped into several categories as described below. In general, the answers did not always include the reasoning behind each change and how the change will reduce leaks and emissions. Greater detail will be shown in the 2018 Compliance Plans required under CPUC Decision 17-16-015.

Blowdown Reduction

SDG&E and SoCalGas report reduction of blowdown emissions from the practice of reducing transmission operating pressure before venting the pipeline for maintenance. SDG&E states they reduced emissions by approximately 116 Mscf, and SoCalGas reduced emissions by about 42,000 Mscf of methane in 2016.

Wild Goose Storage reduced blowdown emissions by bundling projects together that require gas venting, such as maintenance tasks and operational changes.

Damage Prevention

SoCalGas and SDG&E report they are continuing to follow the BPs of the Federal PIPES Act (of 2006) Section 60134(b) to reduce excavation damage. In 2016, they committed to the EPA Methane Challenge program for excavation damage prevention. Pipelines damaged by excavation and similar activities will vent gas until the flow can be controlled.

Distribution Mains and Services

PG&E emphasized continuation of their policy to replace, rather than repair, leaky service lines for a total of 3,951 services replaced in 2016, and a total emissions reduction of 15% for Distribution Mains and Services. Staff has some questions about the necessity of this in instances where an appropriate repair would eliminate the emissions, and PG&E should explain this further in its compliance plan.

SoCalGas reported its replacement of distribution mains and services totaled 46 miles of mains and 8,022 services in 2016, for a total of 1,379 Mscf emissions reduction from this practice.

Leak Detection and Repair

SoCalGas has a program to reduce the inventory of Grade 3 (non-hazardous) leaks, and reports that 799 of these leaks were eliminated in 2016.

SoCalGas stated they are evaluating feasibility of existing mobile mapping technology by measuring atmospheric methane in the vicinity of pipelines to assess conditions prior to replacement of pipeline segments identified by integrity management programs. The results may drive re-prioritization of segments for replacement. In 2016, SoCalGas assessed 50 main replacement projects with a total of 79,866 feet of main and 3 areas of service leak clusters. They discovered 4 leaks from this activity that were not previously known.

SoCalGas and SDG&E are enabling electronic tracking of leaks measured with hand-held survey equipment by adding Bluetooth connectivity to the equipment. Leak measurements will be tagged with GPS location and uploaded for integration with the pipeline Geographic Information System.

SoCalGas and SDG&E jointly installed a dozen methane leak sensors near schools, hospitals and nursing homes in a pilot program to evaluate effectiveness as an early warning device.

SoCalGas and SDG&E also report the use of e-GIS (electronic geographic information system) mapping to identify distribution pipeline leak to optimize the prioritization of pipeline replacements.

Southwest Gas reported they have adopted the more frequent leak repair requirements of GO 112-F including the repair of Grade 2 and Grade 3 within one year of discovery, and that if a leak once downgraded to Grade 3 is later upgraded, it cannot later be downgraded to Grade 3.

Gill Ranch Storage evaluated leak detection procedures and instruments in 2016.

Wild Goose Storage installed remote-controlled exit valve actuators at their well pad to allow for faster pipeline closure in the event of a leak.

Compressor Stations

SoCalGas participates in the EPA Gas Star program to replace compressor engine rod packing on a more frequent schedule, to reduce methane leakage from that source. An

increased replacement interval of 26,000 hours of engine operation drove incremental replacement of 9 packings in 2016. SoCalGas did not report the emissions reduction from this practice in 2016; however, similar efforts in 2015 reduced emissions by 25,085 Mscf of methane from replacement of 29 packings.

Wild Goose Storage installed fuel gas flow meters on four compressor engines to allow for greater tacking of fuel gas consumption and thus greater efficiency with engine operation to minimize emissions.

Gas Storage Facilities

PG&E improved leak monitoring at their McDonald Island storage location by adopting daily leak surveys, aerial surveys, and installation of 3 fixed methane sensors in the facility, in collaboration with Pipeline Research Council International (PRCI). PG&E also installed a Sensit monitor device at the Los Medanos site for a pilot program in collaboration with EDF. Further, PG&E tested the Picarro gas detection vehicle to identify larger leaks on wellheads at Los Medanos.

SoCalGas reports they have begun their SIMP, or Storage Well Integrity Management Program, in 2016. The SIMP program at Aliso Canyon included 38 well inspections, transition of 33 wells to tubing flow only, isolation of 71 wells from the storage zone, abandonment of 1 well, installation of real time pressure sensors across all fields, a new alarm system, and monitoring of tubing, casings and annular space for all wells.

Central Valley Gas Storage conducted a study using a rented, portable compressor to collect and re-inject gas that had leaked from its compressor engine rod packings. The emissions were reduced but CVGS concluded the cost of the added compressor was much greater than the value of the emissions prevented.

High Bleed Pneumatics

Gas facilities often use pressurized pipeline gas as a power source to actuate control and shut-off valves. Some of those devices have a high "bleed" rate: they are designed to vent, or bleed, gas at a high rate in normal operation. These high-bleed devices have been phased out by most operators. SoCalGas has identified a number of these devices that will be replaced in 2016.

Research Projects

SoCalGas funded and participated in a number of research projects aimed to reduce methane emissions:

- Study to refine Emission Factors to more accurately estimate emissions from buried pipelines and meter set assemblies.
- Technology to detect and quantify fugitive and vented emissions including fixed sensors, mobile mapping, optical imaging, aerial detection including drones, and fiber optics.
- Synergistic pipeline safety and integrity technologies including study of an intelligent shut-off device, leak growth rates in plastic piping, and breakaway devices for service risers.
- Damage Prevention measures including fiber optics, acoustic sensing, pipe locating, excavator warning system, and RFID technologies.
- Blowdown emission reduction methods and technologies.

Changes to Emissions Data Reporting

PG&E reported changes in the way emissions were reported for several categories as follows.

- Transmission Pipeline Blowdowns. Due to new EPA requirements (new CFR – 40 CFR 938.232(m)) and to provide more accuracy, PG&E discontinued the assumption of an average value of 125 Mscf for clearances below 250 Mscf and instead used a more accurate calculation for each event.
- Transmission M&R Stations. Emissions in this category increased largely due to the addition of 40 Large Volume Customers (LVCs) by PG&E, which were not previously included in this group. In the previous year, the majority of LVC stations were characterized as Meter Sets, which have a different emissions factor. After further review and understanding of these assets, PG&E decided the LVCs should be considered as a Farm Tap type of station.
- Distribution Mains and Services. PG&E revised the calculation for estimating emissions due to pipeline damage to provide better accuracy. For emissions due to dig-ins and other Distribution Main and Service pipe damage, PG&E made two changes in the flow rate calculation to estimate emission volumes. In previous reports, PG&E has assumed damage occurred at the maximum operating pressure when calculating leak flow from damages, which will overstate the emissions since

pipelines rarely operate at their maximum pressure. In this report, PG&E instead used the normal operating pressure to better represent gas flow conditions at the time of a rupture. Additionally, PG&E reviewed its assumption about the shape of the rupture opening and now believes a majority of the damages caused by external forces (e.g. dig-ins) result in damage, which is inward (puncture) rather than outward (burst). This damage model led PG&E to modify the discharge coefficient in the flow calculation, which resulted in lower emissions volume. Staff observes that it is standard engineering practice to use a discharge coefficient, or multiplier, to model the friction effect of the orifice that gas is flowing through. The coefficient chosen by PG&E, 0.6, is indicative of a very rough-edged orifice.

As noted herein, Staff must evaluate any method changes for their impact on prior year reported emissions to obtain a valid YOY comparison of emissions.

Responses to Data Request Question #7:

Question 7 asks each respondent to provide: "An annual report on measures that will be taken in the following year to reduce gas leaks and emissions to achieve the goals of SB 1371. The report must include a detailed summary of changes, including the reasoning behind each change and an explanation of how each change will reduce methane leaks and emissions."

Small independent storage providers (ISPs) and local distribution operators reported fewer measures because they have simpler operations and have reported a very low emissions baseline. In addition, some of the ISP's gas facilities were built within recent years to modern engineering and safety standards and so may not have as much opportunity for significant emissions reduction.

There were some common approaches among some of the operators, and some unique technical solutions offered as well. The common approaches included increased leak survey frequency; and pipe replacement based on various techniques, such as use of geo-spatial analysis to identify leak-prone pipeline segments. The unique approaches include new technology that is not yet in common use or new applications of existing technology to the emissions problem.

Some of the measures were continuations of programs already in place during the previous year. Staff notes that the Best Practice Compliance Plan will require operators to

identify whether a BP is a new approach or continuation of an existing one under other code requirements.

Emission Reduction practices common to a number of operators:

More than one operator described measures in the following areas:

Leak Survey Frequency

Southwest Gas reported they have already increased their distribution leak survey frequency from the Federal minimum of every five years to a three-year cycle, which achieves earlier leak discovery and also synchronizes with the Federal three-year atmospheric corrosion survey cycle. SDG&E and SoCalGas will accelerate leak surveys for segments of the distribution pipeline built with early vintage Aldyl-A and other leak-prone plastic materials from their current five-year to annual leak surveys.

Pipe Replacement

All four of the largest operators plan to pursue distribution pipe replacement based on integrity management analysis of their pipelines. Integrity Management is an existing requirement under the Federal Gas Safety Code, CFR Title 49, Part 192. These programs require operators to identify and prioritize safety risks such as hazardous gas leaks, and remediate them based on analysis of where leaks have occurred and the causes. This analysis has focused the operator's attention on remediation of pipeline segments made from older pipe materials such as cast iron, unprotected steel, and" early vintage" polymers such as Aldyl-A and PVC.

Geo-Spatial Analysis

"Geo-spatial" analysis helps to identify clusters of leaks. Known leaks are entered into a Geographic Information System (GIS), so that clusters can be visualized and then prioritized for repair or replacement. PG&E, SoCalGas and SDG&E all plan to use this technique in 2017.

Blowdown Reduction

Blowdowns are controlled gas releases that are required to safely perform maintenance on pipelines or other gas facilities. Reduction measures include routing of gas away from the affected area to reduce pressure before release, flaring the gas, or capturing

and re-pressurizing the emissions for re-injection. PG&E has a pressure reduction program for transmission pipeline blowdowns. SDG&E will use the methane capture system developed by SoCalGas, and will collect field data to drive more reductions in future.

In their respective responses to this question no operator explicitly reported the practice of bundling more than one maintenance activity concurrently to minimize blowdowns.

Compressor Station Rod Packing

Transmission operators and storage providers operate compressors to increase gas pressure as needed. Compressor equipment can produce emissions, which operators plan to reduce by more frequent replacement of the compressor rod packing. Central Valley Gas Storage, SoCalGas, and SDG&E all reported plans to increase the frequency of rod packing replacement.

Unique Technical Processes and Practices:

The following measures are unique to a particular operator or are a new application of existing techniques.

Fiber-optic sensing

Fiber-optic sensing could facilitate identifying leaks and encroachment on transmission line right-of-way. This novel approach by SoCalGas makes use of the way the internal molecular structure in fiber-optic glass responds to changes in temperature or mechanical strain. These structural changes are sensed by changes in light scattering through the fiber cable. For leak detection, pressurized gas escaping from a pipe becomes colder, changing the temperature of the fiber optic cable. Construction equipment places a strain on surrounding soil, which produces strain in the fiber optic cable to indicate encroachment of the right of way. SoCalGas is scheduling the first installation of this technology in 2017.

Bluetooth

Mobile handheld devices with GPS equipped with Bluetooth could support direct digital leak mapping for on-foot leak surveyors. Traditional leak surveys are done on foot with handheld leak sensors. Bluetooth communication adds the ability to upload readings, including GPS data, from the handheld devices that may support the use of GIS systems to

plot and analyze the leak data more systematically. SDG&E and SoCalGas are planning to use this approach.

Increased In-Line Inspection (ILI)

PG&E plans to increase its mileage of Transmission subjected to ILI to identify trouble spots in pipelines where leaks may occur. Older transmission lines may require replacement of sharp bends or abrupt diameter changes, for example, to accommodate the ILI tools, so making those changes increases the number of miles that can be inspected. It was not clear whether the increased miles are part of PG&E's existing Federally- required Integrity Management program or if the miles are above and beyond that requirement.

Increased Atmospheric Surveys

SoCalGas and SDG&E plan to do surveys of the atmosphere near pipelines for high methane levels with mobile mapping as an independent means to find pipeline emissions, in addition to traditional leak surveys focused immediately on the pipeline path. Specific technology for conducting these surveys was not detailed. Staff expects further information will be supplied with the upcoming Best Practices Compliance Plan filing due in March 2018.

Coordinate One-Call Excavation Activity

SDG&E and SoCalGas plan to coordinate their One-Call activities with GIS mapping and real-time field technician locations for prompt and accurate marking of pipelines in excavation project areas. SDG&E and SoCalGas think that this approach will give the call center better tools to respond quickly and accurately to an excavator's request for pipeline location marking to reduce dig-ins and the corresponding emissions.

Lessons Learned

Each year Staff tries to identify issues and concerns that affect emissions reporting as well as look for opportunities to improve future emissions reporting. This section tries to focus on lessons that may factor into improving emissions reporting processes and methods. Only a brief description will be noted here because many of the issues have been discussed in the report in greater detail. These items will be included in the agenda for the workshop on potential changes to the annual reporting templates.

Transmission Pipelines:

In particular, PG&E's blowdown events decreased dramatically from 2015 levels, as they used a more accurate method for estimating emissions in 2016.

1. The 2016 methodology shows that the 2015 blowdown emissions were overstated, and for accurate comparison to measurements in later years, the 2015 baseline emissions need to be adjusted. This shows that improving methods could have unintended retrospective impacts to prior year emissions.
2. The reasons for the dramatic change in number of events is believed to be due to bundling maintenance work, however, the reporting entities could not provide more empirical evidence to support the impact of bundling on the number of events versus the ebb and flow of cyclical maintenance work. Different ways to obtain and parses the data should be discussed in order to show how much is due to the change in activity levels and how much is due to bundling efforts.
3. Considering the long-term assessment of blowdown activity: How best to show the discrete blowdown emissions each year to ensure the integrity of comparable emissions accounting YOY?
    a. The engineering variables and formulas were not consistently provided in blowdown worksheets, requiring CARB and CPUC follow up to validate that the emissions are calculated consistently and in accordance with sound engineering estimation principles.
    b. Since the equipment in many, if not most, cases are blown down periodically, how do we show the positive impact of BPs on emission reductions?
    c. Due to the discrete circumstances and nature of each blowdown event, and the activity levels that vary YOY comparisons to prior year emissions are

problematic. Considering that BPs focus on blowdown mitigation activities how should CARB and the CPUC measure the impact of mitigation activities?

d. What additional concerns or considerations need to be taken into account in order to use the discrete component leaks for quantifying emissions from the Transmission Pipeline category?

Transmission M&R Stations:

Respondents reported finding new information about their M&R stations during the data accumulation effort for the 2016 report and re-categorized the M&R stations accordingly. That categorization affected the accounting of 2016 emissions and marked a change in prior year reported emissions. Staff will leave the 2015 reported emissions unchanged in these circumstances and report the 2016 emissions based on the best information about their categorization for 2016.

Distribution Mains and Services:

There were issues with filling out the new Pipeline Summary worksheet in Appendix 4. Because pipeline leak surveys are done on multi-year cycles, Staff made significant modifications to DM&S pipeline reporting templates for 2016 to include estimates of the leaks expected to have occurred on the un-surveyed portions of the pipeline system, which improved granularity of the data reported. However, the complexity of the worksheets created confusion for respondents filling out the templates. Staff worked with respondents to ensure consistency in reporting and integrity of the data. Some of these issues are highlighted below.

1. How to determine the "average days to repair leaks" by grade. Modify the instructions provided to clarify using the leak repaired date minus the date of the leak discovered and add one day.
2. In 2016, the leaks anticipated from the un-surveyed areas were not allocated to the different grades due to concerns of overstating the grade 1 leaks based on the ratio of leaks detected in the current year. It would be helpful to understand the best methods for trying to approximate the probability of occurrence of leaks by grade annually.
3. Leaks upgraded from a grade 3 need to be identified, and the date upgraded should be noted or obtained to reset the clock for repair response time.

4. In 2015 and 2016, a majority of leaks in PG&E's system are on pipelines, where the material type is unknown. PG&E should determine how to resolve this discrepancy or to work around it with better empirical information to allocate emissions to the corresponding pipe material for these leaks.
5. PG&E can only identify pipe material for about 16% of their 6,920 leaks carried over Pre-2016, and 47% of the 8,270 pipeline leaks discovered in 2016. For the remaining 84% of pre-2016 leaks and 53% of 2016 leaks on unknown pipe materials, PG&E assigned them based on a proportional distribution of data set with known pipe material. This assumes that the materials are ratably dispersed through their entire service territory. However, Staff is concerned that this assumption is not supported by sufficient empirical data so that the pipeline emissions estimate will not be reasonably accurate.

Staff notes that each utility uses its own methodology and various assumptions to estimate damages emissions that make direct comparisons between respondents difficult and unwarranted. For example, SoCalGas and SDG&E used historical emissions profiles to establish an average emission estimate for about 30% of their damage events. They also use a self-generated EF for above-ground MSA damages when specific event information was not available to calculate the emissions. SoCalGas/SDG&E also incorporate the leak grade to determine the level of emissions for the damage event.

Impact of Increasing the Frequency of Leak Surveys:

Increasing the frequency of leak surveys is often offered as a good way to reduce emissions of pipeline systems. Further work needs to be done to understand the cost benefit of such changes. This will be addressed through Respondents' compliance plans that demonstrate implementation of Best Practices. Staff would like respondents to help develop a theoretical analysis for determining the amount of emissions reduction, which could occur by increasing the frequency of the graded leak surveys (e.g. from 5 to 4 years, etc.). Preliminary investigations indicate that respondents are capable of providing theoretical estimates of emissions reductions expected from shifting from a 5-year to a 4-year survey cycle, or from a 4-year to a 3-year survey cycle.

A set of common assumptions should be required in order to establish a consistency across emissions reduction estimates by respondents. Ideally, the assumptions should be mutually agreed to by parties. The assumptions could include: region specific distribution of

pipeline material, specific regional leak rate, proportion of mains and services in the different regions, the age assets by sector or region, and the foot print of the areas to be surveyed in each year.

This topic will be added to the discussion for the updating reporting templates in the workshop planned for winter 2018.

Customer Meters:

Damages for above ground DM&S infrastructure associated with MSAs needs to be separated out from the DM&S pipeline damages. The MSA related damages need to be included in the MSA systems category. The impediment to that is overcoming PG&E's issues reporting them separately.

Underground Storage:

Staff found that the reporting guidelines (Appendix 9) for dehydrator emissions need to be updated to include glycol based dehydrators, which have a vapor recovery unit and a combustor/oxidizer or recovery system. Appendix 9 also should provide updated instructions on how to estimate dehydrator emissions.

Conclusions

The report provides a framework for understanding the data submitted in the June 17, 2016, reports and subsequent resubmittals. The major findings are:

1. The total 2016 reduction of 5% from 2015 baseline emissions were primarily driven by reduction in blowdown and venting emissions. There were small decreases in pipeline leaks and compressor emissions, which were offset by small increases in emissions from damages and component leaks and emissions (Table 1).
2. Significant reductions in blowdown emissions took place in 2016 attributed to implementation of BPs for bundling work, concerted efforts to reduce line pressure before blowdown, and cyclical changes in facilities maintenance. The amounts of emission reduction associated with these different activities are difficult to evaluate due to the lack of empirical data and performance metrics used by the respondents.
3. The majority of reported emissions (62%) come from population based emission estimates that rely on EFs rather than measurements, and are expected to remain relatively constant over time (Figure 2).
4. If significant changes to EFs occur based on improved information that affects baseline emissions levels, Staff must consider the implications of any changes and the potential adjustments to the baseline to avoid incorrectly accounting for emissions over time.

   In the short term, continued use of EFs is acceptable. However, in order to better quantify emission reductions over time respondents must devise better ways to measure actual leak volumes. Because it is difficult to quantify the actual volume of leaks and emissions, more work is needed to develop and improve California specific EFs until actual emissions measurements are available for the sources where it is feasible to directly measure emissions.
5. The second largest emissions category (22%) came from graded leaks (Table 7). Grade 3 leaks make up 52% of graded leak volume, and 12% of the total overall emissions volume (Table 13). Of the unrepaired leaks that were carried over from prior years, 96.5% of the emissions come from grade 3 leaks. Eliminating the backlog

of grade 3 leaks carried over to 2016 could decrease the overall emissions inventory by 7%.[41]

6. The emissions from pipeline leaks that are estimated to come from un-surveyed DM&S pipelines make up 39.2% of the 2016 graded leaks (Table 13). The estimated un-surveyed emissions make up 9% of the total 2016 sector emissions. Increasing the frequency of leak surveys should reduce graded pipeline emissions, by reducing the lengths of time until leaks are detected and repaired.
7. Record keeping issues have a significant impact on estimating emissions accurately. An ongoing concern is that key factors used for quantifying, categorizing and calculating emissions are not available and Staff must accept assumptions without empirical support. (See the example provided in section detailing DM&S results.) This increases the likelihood that emissions estimates are not sufficiently accurate, which would make reported emissions unreliable.

   In 2016, challenges with consistent application of reporting template guidelines and understanding the reporting requirements continued. In a few cases Respondents did not include emissions because they were not subject to CARB's Mandatory Reporting Requirement (MRR). The Commission does not restrict the reporting of subject emissions to those subject to MRRs. Staff plans to discuss the reporting thresholds and revise reporting templates to clarify that any and all system emissions that can be identified, estimated and measured should be reported.

[41] The 7% emissions reduction is based on the 2016 grade 3 leaks carried over from prior years of 437 MMscf which is 7% of the 2016 emissions. Grade 3 leaks are discovered every year and all else being equal, eliminating the prior carry over of grade 3 leaks would in the case of 2016 reported emission figures, net 7%.

Appendix A: Methods for Estimating Emissions

Explanation of methods used for reporting and estimating leaks and emissions in the Joint Report.		
System Categories	**Emission Source Categories**	**Description**
Transmission Pipeline	Pipeline Leaks	Pipeline operators were instructed to provide emissions using the approved EF by number of miles of pipeline. It was determined that use of the emission factor from INGAA Greenhouse Gas Emission Estimation Guidelines for Natural Gas Transmission and Storage - Volume 1 GHG Emission Estimation Methodologies and Procedures (September 28, 2005 - Revision 2) - Table 4-4 study would be the best available for Transmission Pipeline emissions at this time.
	All damages (as defined by PHMSA)	Event specific emissions data reported where emissions were estimated either from modelling or size of breach using pressure and duration to calculate the emissions.
	Pipeline Blowdowns	The blowdown emissions are calculated based on unique equipment attributes and measured with engineering calculations on an individual basis.
	Component Emissions:	The emissions from components associated with transmission pipeline operations are based on the recommended EFs outlined in Appendix 9 of the Data Request. In some cases, the components did not meet the definition for the EFs and discrete approximations based on manufacturer provided leak rates, direct measurement of the different operating states as well as the for specific values recommended for use in calculating component specific leaks times number of units of equipment.
	Pneumatic Devices	
	Pressure Relief Valves	
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive component leaks in this category. This differentiates them from emissions from components that result from normal operations or by design. No emissions were reported in this category for RY 2016.
	Odorizer (Odorizer and Gas Sampling Vents)	The EFs recommended in Appendix 9 were used where directly applicable, however where transmission pipeline dehydrator equipment did not match the pipeline operators used the discrete equipment attributes and operations profile to estimate emissions. The methods used appeared to provide the best estimate of emissions given the variety and operating context of these facilities.
Transmission M&R	M&R Stations	The emission estimate for M&R stations are based on the EFs recommended in Appendix 9 multiplied by the population of each type of M&R station.

	M&R Components Emissions.	The purpose of this category is to capture emissions that occur in M&R station components that result from normal operations or by design of the component. The emissions from components are captured in the EF used on a station by station basis and the discrete information on a subset of components in the facility would duplicate emissions and present misleading count information. Until further work can be done with more comprehensive survey techniques relying on the recommended EFs on a station by station basis is considered the best estimate of emissions at this time.
	M&R Leaks	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on components within the M&R station, and create a record as a basis for evaluating using actual measured leaks rather than an M&R station EF for estimating emissions. Currently the discrete leaks for M&R stations would be captured in the recommended EFs used to estimate the M&R station emissions and only where it could be determined that inclusion of discrete M&R leaks were not duplicated would they be included in the count of emissions for this category.
	M&R blowdown	Blowdown emissions were estimated based on the calculation of the unique equipment volume being vented corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
Transmission Compressor Stations	Compressor Equipment - Centrifugal and Reciprocating.	The emissions calculated based on the direct measurement of each compressor unit given its operating state and pressure, and then the emissions are based on number of operating hours in each operating state.
	Compressor Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive leaks in this category, and differentiate them from emissions from compressors that result from normal operations or by design. There were no discrete compressor leaks in RY 2016.
	Equipment and pipeline blowdowns	Blowdown emissions were estimated based on the calculation of the unique equipment volume being vented corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	Components Emissions.	The equipment and component emissions are based on the leaks detected at the compressor stations times the recommended EF for that type of equipment per Appendix 9. The purpose of this tab is to capture emissions that result from normal operations or by design.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive component leaks in this category. This differentiates them from emissions from components that result from normal operations or by design. No emissions were reported in this category for RY 2016.

	Compressor Station Storage Tanks	These emissions are based on discrete tank pressure fluctuations due to exterior temperature fluctuations. The initial volume of gas release calculation is based on the starting and ending pressures assuming a constant temperature.
Distribution Mains and ervices Pipelines	Pipeline Leaks - Below Ground	The emissions from leaks detected in 2016 in Distribution Mains and Service pipelines are calculated assuming that the leak was emitting from the first day of the calendar year through date of repair, or the entire year if not repaired in 2016, times the recommended EF. For identified leaks carried over from prior years the emissions are calculated from the beginning of the year through repair date (if repaired in 2016) or end of year times the recommended EF. In addition, leaks occurring in un-surveyed parts of operator's service territory were estimated based on the leak occurrence rate in the surveyed portion of the territory extrapolated based on number of years in the survey cycle to come up with the number of expected leaks in the un-surveyed territory times the recommended EF. This method of estimating the emissions from leaks occurring in un-surveyed portions of the service territory is considered a reasonable way of approximating the emissions and takes into account the frequency of leak detection surveys.
	Pipeline Leaks - Above Ground	See above for below ground leaks. Above ground leaks associated with MSAs are not counted in the volume or the numbers of leaks in order to prevent misleading representation of emissions as well as potential for duplication of emissions volumes.
	Blowdowns and Venting	Blowdown emissions were estimated based on the calculation of the unique equipment volume corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	All damages (as defined by PHMSA)	Emissions from damages for Above Ground (AG) Non-hazardous and MSA damages are calculated based on company emission factor for above ground facilities times the number of days leaking unless an engineering estimate could be performed to measure the emissions. For AG Hazardous and Below Ground Code 1 damages, emission was estimated based on engineering calculation using pipe size, damage opening size, and duration. For Code 2 and Code 3 damages, the emission factor for Distribution pipeline leaks was used. In 2015 and 2016 all damages for DM&S above and below ground as well as MSA above ground damages are aggregated in this category.
		Where an estimate was not made at the time of the event, the emission was estimated from population of similar events with respective pipe material and pipe size.

	Components - Pneumatic Devices	Emissions from components such as pneumatic devices are based on manufacturer specifications for bleed rate given the pressure.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive component leaks in this category. This differentiates them from emissions from components that result from normal operations or by design. No emissions were reported in this category for RY 2016.
	Odorizer (Odorizer and Gas Sampling Vents)	Not applicable for this category.
Distribution M&R Stations	M&R Stations	The emission estimate for M&R stations are based on the EFs recommended in Appendix 9 multiplied by the population of each type of M&R station.
	Blowdowns	Blowdown emissions were estimated based on the calculation of the unique equipment volume corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	Component Emissions	The purpose of this category is to capture emissions that occur in M&R station components that result from normal operations or by design of the component. The emissions from components are captured in the EF used on a station by station basis, and any discrete leak information from components in the facility would duplicate emissions and present misleading count information. Until further work can be done with more comprehensive survey techniques, continued reliance on the recommended EFs on a station by station basis is considered the best estimate of emissions at this time.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on components within the M&R station, and create a record as a basis for evaluating using actual measured leaks rather than an M&R station EF for estimating emissions. Currently the discrete leaks for M&R stations would be captured in the recommended EFs used to estimate the M&R station emissions and only where it could be determined that inclusion of discrete M&R leaks were not duplicated would they be included in the count of emissions for this category.
Commercial, Industrial and sidential Meters	Residential and Commercial Meters	The emissions for this category is based on the MSA population count times the recommended EF per Appendix 9. There is substantial work currently being done to update EFs for MSAs and in future any updated EFs could be backward applied to 2015.

	Actual MSA Leaks	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on MSAs, and create a record in order to form a basis for evaluating using actual measured leaks rather the number of meters in the population times an EF to estimate emissions. Currently the discrete MSA leaks would be captured in the current method using EFs time the population of meters.
	All damages (as defined by PHMSA)	Emissions from damages for Above Ground (AG) Non-hazardous MSA damages should be calculated based on company emission factor for above ground facilities times the number of days leaking. For AG Hazardous damages, emission should be estimated based on based on engineering calculation using pipe size, damage opening size, and duration. The reported damages in this category were re-categorized and included with DM&S pipeline damages because not all respondents were capable of separating out their AG - MSA related damages with their AG - DM&S damages. Grouping them all together in this year's report is consistent with the grouping used in 2015. However, in the future separating the respective AG damages will help differentiate the source of damages and emissions.
	Component Emissions:	This new category was added to the reporting templates for RY 2016. The purpose of this category is to capture fugitive leaks on components other than MSAs in the MSA systems to determine whether such leaks existed. In addition, if such leaks existed this could form a basis for evaluating using actual measured leaks rather than an EF for estimating emissions. No component leaks were identified or reported in 2016.
	Vented Emission from MSA	Emissions from venting MSAs are based on the number of events times the estimated volume release by MSA and/or the type of activity.
Underground Storage	Facility Leaks	Emissions in this category are based on EPA GHG Subpart W data EFs multiplied by the number of units of each equipment type. Or respondents may use EFs from MRR Leaker Emission Factor Table W-4, or they may choose to use Leaker based EFs, which means that if a survey is conducted, those components found not to be leaking would be recorded with zero emissions as opposed to applying a population based EF. Just as those components found to be leaking would use a "Leaker EF" with a proscribed value.
	Compressor Emissions	Emissions from storage facility compressors are calculated in the same manner as for compressors in other categories. See the description in the Compressor Station category.
	Compressor Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive leaks in this category, and differentiate them from emissions from compressors that result from normal operations or by design. The emissions from components associated with compressor operations are based on the recommended EFs outlined in Appendix 9 of the Data Request.

	Blowdown and Venting	Blowdown emissions were estimated based on the calculation of the unique equipment volume corrected for pressure and temperature at the time of the release. The estimates for blowdown events in general provide a reliable emission estimate.
	Components Emissions:	Component emissions are based on the emissions that occur as a result of normal operation of the component or its design. The emissions detected during GHG leak survey pursuant to the GHG Mandatory Reporting Regulation and each component's EF times the population count. All leak and component emission estimates are based on the assumption that the leak is leaking the entire year or during its identified hours of operation.
	Component Leaks:	This new category was added to the reporting templates for RY 2016. The purpose is to capture fugitive leaks in this category, and differentiate them from emissions from components that result from normal operations or by design. The emissions from components associated with transmission pipeline operations are based on the recommended EFs outlined in Appendix 9 of the Data Request.
	Dehydrator Emissions	Because there are several different types and configurations of dehydrators and it was determined that the majority of respondent's dehydrators use a control device to eliminate natural gas emissions. Therefore, only those dehydrators which vent natural gas are included in this category. The dehydrator emission estimate is based on the engineering estimate, manufacturer's data, or MRR prescribed method of calculating natural gas emissions.

Appendix B: Definitions

For the purposes of SB 1371, the definitions of "leak" and "gas -loss" and the formula for calculating a "system-wide gas leak rate" were defined in a different manner than elsewhere. A "leak" was defined as any breach, whether intentional or unintentional, whether hazardous or non-hazardous, of the pressure boundary of the gas system that allows natural gas to leak into the atmosphere. In essence, any vented or fugitive emission to the atmosphere is considered a "leak". Examples of leaking components include defective gaskets, seals, valve packing, relief valves, pumps, compressors, etc. Gas blowdowns during the course of operations, maintenance and testing (including hydro-testing) were also included as leaks. Consequently, this leak definition is broader than the Pipeline Hazardous Material and Safety Administration's (PHMSA) definition.

The gas respondents are required by Federal Law, 49 CFR 192, to survey their systems for leaks, which could be hazardous to public safety or property. To accomplish this, the gas utility companies developed graded leak programs to detect, prioritize and repair the safety related types of leaks. The same definitions are used within this report and are as follows:

- Graded Leaks –hazardous leaks or, which could potentially become hazardous as described below:
  - A "grade 1 leak" is a leak that represents an existing or probable hazard to persons or property and requiring prompt action, immediate repair, or continuous action until the conditions are no longer hazardous.[42]
  - A "grade 2 leak" is recognized as being non-hazardous at the time of detection but justifies scheduled repair based on the potential for creating a future hazard.[43]
  - A "grade 3 leak" is a leak that is not hazardous at the time of detection and can reasonably be expected to remain not hazardous.[44]

- Vented Emissions are releases of gas to the atmosphere, which occur during the course of operations or maintenance, for a safety reason. Some examples are:
  - Purging (a.k.a. "blowdown") gas prior to hydro-testing a line.
  - Gas releases designed into the equipment function, such as gas emitting from relief valve vents or pneumatic equipment.
  - Gas releases caused by operations, maintenance, testing, training, etc.

42 Refer to GO 112-F for more information.
42 Ibid.
44 Ibid.

- Ungraded Leaks are the remaining leaks, which are not hazardous to persons and/or property.

For further information please see CPUC GO 112-F.

Lastly, in 2014 the system-wide gas leak rate was calculated as a percent of total input for the 12 months ending June 30 of the reporting year. However, Staff determined that there were problems with this calculation and opted not to report a leak rate using this formula. The formula for calculating a system-wide gas leak was written as follows:

Pipeline Hazardous Material and Safety Administration (PHMSA) Modified Equation for Lost and Unaccounted for (LAUF) Gas:

[(Purchased gas + produced gas + transported gas entering the gas system) minus (customer use +company use + appropriate adjustments + gas injected into storage + transported gas leaving the gas system)] divided by (Purchased gas + produced gas + transported gas entering the gas system) = System Wide Gas Leak Rate.

Note: transported gas includes gas purchased by customers and transported in common carrier pipelines.

In section 5 of the 2015 Joint Report, "Baseline System-Wide Emissions Rate," Staff determined the value for 2015 to be 0.32% by using the total emissions from all source categories (6,601.2 MMscf) divided by the Total Annual Volume of Gas Transported (2,056,950 MMscf). The five sources for Total Annual Volume of Gas Transported are listed on pages 50 and 51 of this report.

Appendix C: Article 3, Section 975 (c) and (e)(6)

Article 3. Section 975

(c) As soon as practicable, the commission shall require gas corporations to file a report that includes, but is not limited to, all of the following:

(1) A summary of utility leak management practices.

(2) A list of new methane leaks in 2013 by grade.

(3) A list of open leaks that are being monitored or are scheduled to be repaired.

(4) A best estimate of gas loss due to leaks.

(e) The rules and procedures adopted pursuant to subdivision (d) shall accomplish all of the following:

(6) to the extent feasible, require the owner of each commission-regulated gas pipeline facility that is an intrastate transmission or distribution line to calculate and report to the commission and the State Air Resources Board a baseline system-wide leak rate, to periodically update that system-wide leak rate calculation, and to annually report measures that will be taken in the following year to reduce the system-wide leak rate to achieve the goals of the bill.

Appendix D: Conversion of Natural Gas to Carbon Dioxide Equivalents

The conversion of natural gas volume to carbon dioxide equivalent mass requires the use of a GWP value. CARB used the GWP value of 25 (100-year value) from the IPCC, AR4, for previous GHG emissions inventory. The following calculations show the conversion of the total emissions from this report. The conversion was done in two steps. In the first step, the calculation shows the volumetric natural gas that contains exactly one metric ton of methane.

$$1\ MT\ CH4 * \frac{2{,}204.62\ lbs\ CH4}{1\ MT\ CH4} * \frac{1\ lb\ mole}{16.04246\ lb\ CH4} * \frac{379.48\ scf\ of\ CH4\ gas}{1\ lb\ mole}$$

$$* \frac{1.0\ scf\ of\ natural\ gas}{0.934\ scf\ of\ CH4\ gas} * \frac{1\ Mscf}{1{,}000\ scf} = 55.835\ Mscf\ of\ natural\ gas$$

Using this volumetric unit, the 2015 total emissions, 6,267 MMscf, is equivalent to about 2.81 MMTCO2e, as shown below:

$$6{,}266{,}544\ Mscf\ natural\ gas * \frac{1\ MT\ CH4}{55.835\ Mscf\ of\ natural\ gas} * \frac{25\ CO2e}{1\ CH4} = 2{,}805{,}831\ MT\ CO2e$$

CARB has also used the GWP value of 72 (AR4, 20-year) in the Short-Lived Climate Pollutant Plan and Oil and Gas Regulation. Based on the higher GWP, the 2016 total emissions, 6,267 MMscf, is about 8.08 MMTCO2e, as follows:

$$6{,}266{,}544\ Mscf\ natural\ gas * \frac{1\ MT\ CH4}{55.835\ Mscf\ of\ natural\ gas} * \frac{72\ CO2e}{1\ CH4} = 8{,}080{,}794\ MT\ CO2e$$

The use of 1.0 scf of natural gas per 0.934 scf of CH4 gas accounts for composition of natural gas being not 100% methane. The American Gas Association published a value of 93.4% to be used as a default methane concentration that is comparable to what respondents' reported.[45]

The standard cubic foot "scf" for measuring gas is based on 60 degrees Fahrenheit at atmosphere pressure.

In addition, respondents reported trace amounts of concentration for ethane, inert gases, and other elements and compounds. There was not an entry for carbon dioxide explicitly, and so it cannot be assumed that all of the inert gas was carbon dioxide. A

[45] AGA, GHG Guidelines, page 39, April 18, 2008, http://s3.amazonaws.com/zanran_storage/www.aga.org/ContentPages/18068841.pdf

calculation was performed that showed CO2 emissions from the inert gases would be less than 0.1% of the total, and is excluded in this report.

Appendix E: Proposed Changes to Data Request Template

The proposed template changes will be discussed in the workshop planned for the winter 2018. See Lessons Learned section of the report where the discussion of those issues may lead to changes to the reporting templates. The following template changes are planned for the workshop:

Appendix 4:

- Add worksheet requiring miles in of pipeline in the system.
- Add a new column to identify if/when a leak grade has changed up/down upon later inspection. This information facilitates calculating average days to repair leaks by grade.
- Add a comment box in the Summary worksheet that the formula for average days to repair leaks is "Repair Date minus Discovery Date plus one day."
- Add a comment box in the All Damages worksheet in Appendix 4. The comment box will outline the formula for calculating the average days to repair a leak which is defined as "Repair Date minus Discovery Date plus one day."

Appendix 6:

- Add a comment box in the All Damages worksheet in Appendix 6. The comment box will outline the formula for calculating the average days to repair a leak which is defined as "Repair Date minus Discovery Date plus one day."
- Change the emissions units of measure in the Vented and Emissions worksheet for the blowdown units from "Mscf/yr." to "Mscf/event."

Appendix 7:

- Add a column on the Dehydrator worksheet requiring a description of the dehydrators in use at each facility and a column for their respective quantity. Dehydrators are a discussion topic for the winter 2018 workshop.

Appendix 8:

- Add a new worksheet in Appendix 8's Summary for "Explanations for Year-Over-Year Changes." Respondents should include the baseline (2015), current and prior year emissions reported by line item category. Columns calculating amount and percent change from period to period will be included as well. These columns should be self- explanatory and will be covered in the winter 2018 workshop. Both positive and negative significant differences should be explained. The definition of what is significant will be discussed at the workshop.

- Correct minor formatting issues and try to clean up unnecessary references, such as the width of worksheet headers and sizing the comment boxes to reveal content.
- Update the category line items in Appendix 8 for any additional worksheet added or changed in all the other templates. Where appropriate designate the intent of the data whether for reporting or for informational data collection.

Appendix F: Methodology Change - Impact on PG&E's 2015 Transmission Blowdown Baseline

In 2016 PG&E made a significant change to its methodology for transmission pipeline blowdown emissions, whereby it calculated all blowdown emissions rather than using 125 Mscf for pipeline blowdowns estimated to be below 250Mscf. The 125 Mscf median was also assumed to be the mean value. Due to the empirical data provided from the 2016 blowdown calculations the mean average for blowdown events below 250 Mscf was determined to be 47.3 Mscf.

PG&E concurred that the 47.3 Mscf mean value would likely apply to 2015 blowdowns which were based on the median of 125 Mscf. The net impact of this change in assumption would result in a reduction of 67,444 Mscf to the 2015 transmission blowdown emissions.

Impact on 2015 Transmission Pipeline Blowdown Emissions (Mscf)

	Average Mscf/Event
Mscf/Event Median Value Used in 2015	125.0
Actual Mean Value Calculated in 2016	47.3
Overstated Emissions Per Event (Mscf)	77.7
	Number of Events
Number of 2015 Pipeline Blowdown Events Below 250 Mscf	868.0
Amount of 2015 Baseline Overstated (Mscf)	67,444